SAE journal

JANUARY 1956

IN THIS ISSUE . . .

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Published by The Society of Automotive Engineers

AHEAD

• in popularity!
• in performance!

51.9% OF THE 7,341,906 passenger cars produced in the U.S. from January 1st through December 3rd, 1955 were equipped with new Type "98" oil ring. 48.1% were equipped with all other oil ring types, including other Perfect Circle oil rings.

THE NEW PERFECT CIRCLE TYPE "98" CHROME OIL RING has been proved better than any other oil ring for high-compression, high-vacuum overhead valve engines. Gives uniform pressure on entire circumference. Multiple tiny springs exert both side and radial pressure. Provides maximum oil drainage. Universal application . . . bottomless and conventional grooves, all depths.

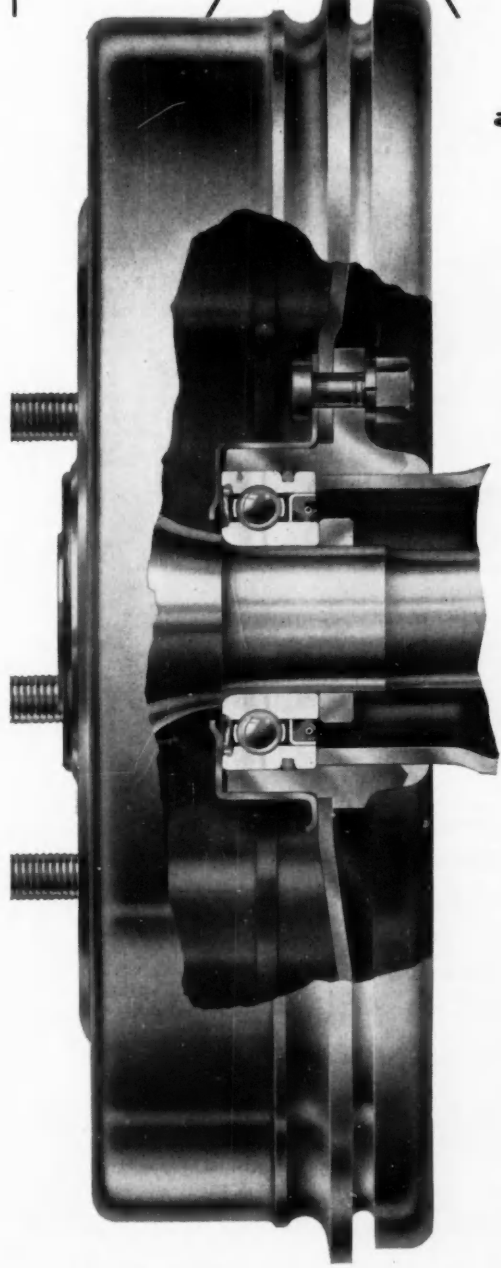
Perfect Circle

Perfect Circle Corporation, Hagerstown, Indiana;
The Perfect Circle Co., Ltd., Toronto, Ontario

U. S. Patent Nos. 2,635,022 and 2,695,825

FACTS

about **NEW DEPARTURE** BALL BEARINGS



New Departure's Sealed-for-Life Rear Wheel Bearing is press-fitted to its seat—without need for locknuts, threads, or grooves to weaken the shaft.

30,000,000 rear wheel bearings can't be wrong!

This New Departure rear wheel application is an outstanding example of the advantages ball bearings provide automotive designers for increased dependability at lower cost.

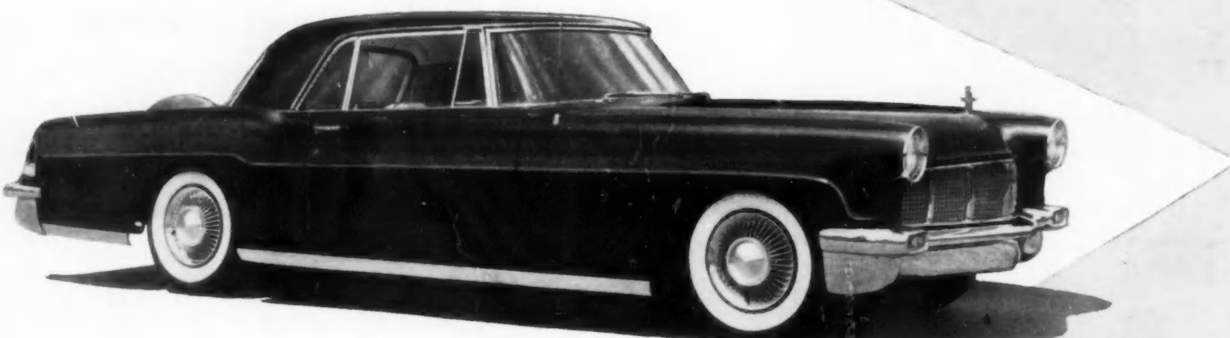
As proved more than 30,000,000 times, New Departure Rear Wheel *ball bearings* permit the design of simpler, stronger, more foolproof axle mountings . . . and the savings ball bearings bring in machining, assembly, and axle parts cut production costs substantially.

New Departure Rear Wheel Bearings, mounted this way, eliminate locknuts, threads, and grooves—never require adjustment. They are "Sealed and Lubricated for Life," giving the service-free qualities that have earned them the description "*built to be forgotten*" . . . and a reputation of outlasting the product they serve.

Remember—leading auto makers, like the leaders in every industry, depend on New Departure for outstanding *quality and engineering service.*

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONN.

the Continental—*Mark II*



The Car of Cars

Rarely indeed has the birth of a new car been heralded with the enthusiastic acclaim accorded this newest arrival in motordom. It is with thrilling admiration that Gabriel salutes the designers and builders of this motoring masterpiece. That Gabriel Shock Absorbers were selected as standard equipment for this ultra fine automobile is a matter of signal pride to The Gabriel Company.

GABRIEL
The greatest name
in ride control

THE GABRIEL COMPANY, Cleveland 15, Ohio

SAE JOURNAL, January, 1956, Vol. 64, No. 1. Published monthly except two issues in January by the Society of Automotive Engineers, Inc. Publication office, at 10 McGovern Ave., Lancaster, Pa. Editorial and advertising department at the headquarters of the Society, 29 West 39th Street, New York 18, N. Y. $1 per number; $10 per year; foreign $12 per year; to members 50 cents per number, $5 per year. Entered as second class matter, September 15, 1948 at the Post Office at Lancaster, Pa., under the act of August 24, 1912. Acceptance for mailing at special rate of postage provided for in the Act of February 28, 1925, embodied in paragraph (d-2), Sec. 34.40, P. L. and R., of 1948. Additional entry at New York, N. Y.

The use of Dyna-seals under bolt heads of the periscope mounting on the nuclear submarine Seawolf will provide positive sealing up to 10,000 P.S.I. Uncompromising requirements of the Precision Dyna-seal were controlled by rigid specifications.

Use performance proved Dyna-seal to solve your problem. Its one piece bonded steel and synthetic rubber construction provides economy and dependability . . . eliminates special machining and over torquing of bolts . . . assures vibration-proof lock washer action!

Compression molded Precision "O" Rings protect Seawolf fuse boxes. Controlled quality, assured through rigid specifications and inspection, is your guarantee of reliable performance in **your** product.

What is your sealing problem? There's an expert – the Precision Engineer – ready to help you.

Write for your free personal copies of the Precision handbook on "O" rings and the Dyna-seal Engineering Data Book.

Precision Rubber Products CORPORATION

"O" Ring and Dyna-seal Specialists®

3110 Oakridge Drive, Dayton 7, Ohio Canadian Plant at: Ste. Thérèse de Blainville, Québec

Watson Bros. ...one of the world's largest...adds 65 Fuller ROADRANGER® Transmissions to Expanding Fleet

Performance of 720 Fuller Transmissions in service prompts selection of semi-automatic units.

Today, the Watson Bros. Transportation Co., Inc., of Omaha, Nebraska, is rated as fourth largest common freight carrier operation in the United States . . . with 2400 units transporting 2,200,000 shipments annually over 60,000,000 miles.

Watson Bros. has just added 65 new modern tractor units, including:

40 West Coast International diesels equipped with Fuller 10-speed R-95-C Semi-Automatic ROADRANGER Transmissions,

15 Diamond T's putting horsepower to work through Fuller R-950-C Semi-Automatic ROADRANGER Transmissions, and a fleet of

10 R-195 Internationals equipped with Fuller 8-speed R-46 Semi-Automatic ROADRANGER Transmissions.

The performance of 720 Fuller Transmissions already in service for the pioneer Omaha common carrier was a prime reason for specifying Fuller Transmissions in their new equipment.

L. E. Erlewine, Superintendent of Maintenance for Watson Bros. since 1932, puts it this way: "The design of the ROADRANGER allows us to operate tandem-drive axles in both 50-foot and 55-foot states. Because of the ROADRANGER design we get more traction, resulting in safer operation. We need no chains on ice, and pull away from rigs using chains on the same grade. The performance of the semi-automatic ROADRANGER *adds up* to longer engine life, easier shifting, faster average speeds and greater fuel economy."

Fuller Transmissions make shifting fast and easy . . . and let the driver select the ratio he needs at the *right* time to meet every varying condition of time, traffic and terrain.

FULLER MANUFACTURING COMPANY
TRANSMISSION DIVISION • KALAMAZOO, MICH.

Unit Drop Forge Div., Milwaukee 1, Wis. • Shuler Axle Co., Louisville, Ky. (Subsidiary) • Sales & Service, All Products, West. Dist. Branch, Oakland 6, Cal. and Southwest Dist. Office, Tulsa 3, Okla.

From a dream-world marriage of mathematics and electronics...tomorrow's oil seals today

Looks simple, doesn't it—the oil seal pictured here. Actually, it's a precision assembly of high tolerance parts, each the product of painstaking engineering.

One such part is the unseen but vital tension spring behind the sealing lip. Thousands of these springs—all different—are needed in the broad line of National Oil Seals. Each spring must have exactly the size, coil diameter, tension, spring rate, and heat treat required for the oil seal it fits.

Done the conventional way, calculations of characteristics for thousands of springs would take months. So, National Oil Seal Engineers developed new mathematical methods which, in combination with Univac, permit specifications to be determined at speeds up to 150 per minute.

This fortunate marriage of mathematics and electronics is another example of efficient, "future" National Oil Seal engineering—and another reason why National consistently brings you tomorrow's oil seals today.

NATIONAL
OIL & GREASE SEALS
O-RINGS SHIMS

New Sealing Lip Design. Recent development of NMB Engineering is new lip design. New features include long, thin lip section and small coil diameter tension-spring. Contact on shaft is light, yet effective sealing is maintained throughout long service life.

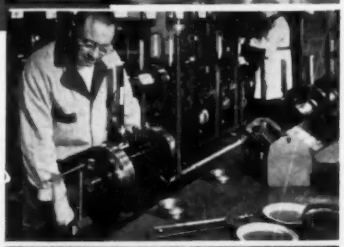
NATIONAL MOTOR BEARING CO., INC.
General Offices: Redwood City, California
Plants: Redwood City, California and Van Wert, Ohio

8548

Here's how C/R COOPERATIVE RESEARCH *can help you*

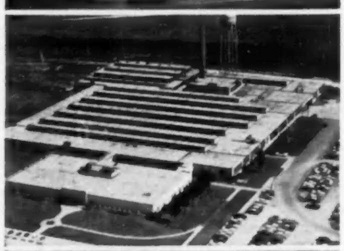
DESIGN . . . When your product is on the drawing board is the time to correlate design and materials with performance requirements. C/R's expertly-staffed engineering groups working in close cooperation with the material labs have done it for others . . . and can do it for you.

MATERIALS . . . Pioneers in the development of Sirvis (mechanical leather) and Sirvene (synthetic rubber) parts for oil seals and other mechanical applications, C/R will custom-develop materials for your special needs in our synthetic rubber or leather laboratories.



PRODUCT TESTING . . . Many products, new and present, need extensive checking. C/R testing labs often work many months to verify designs, eliminate trouble. This is standard procedure on all C/R stock products . . . essential in developing yours.

TROUBLE SHOOTING . . . Auto and heavy equipment makers, as well as manufacturers in most fields you can think of, have solved difficult sealing and related problems with the help of C/R Cooperative Research. You can, too . . . and save time, trouble and money.



PRODUCTION . . . Six plants, operating as extensions of C/R Cooperative Research, provide laboratory-like quality control, timed to your needs. C/R Sales Engineering follows through to coordinate and assure satisfaction.

EXPERIENCE . . . Broadest in the field. Proof? More automobiles, farm equipment and industrial machines rely on C/R Oil Seals than on any similar sealing device. C/R diaphragms, boots and gaskets are in the same top categories.

HELP YOU ENGINEER YOUR PRODUCT, ELIMINATE TOUGH TROUBLE SPOTS AND SAVE YOU MONEY IN FLUID SEALING AND RELATED FIELDS

Developing a new product or rectifying trouble in a present one? Why not supplement your own engineering facilities with C/R Cooperative Research? In the areas related to oil seal design, lubricant, chemical, gas, or air retention, and foreign matter exclusion—as well as in the development of synthetic rubber and impregnated mechanical leather parts—Chicago Rawhide's developmental facilities are the most extensive in the country.

All of them are at your service . . . for help with your critical or unusual problems. You may be sure that your design specifications, performance requirements, and production controls will be met to the letter. A few of the many ways in which C/R Cooperative Research serves other leading manufacturers are pointed out on this page. We'll be glad to help you.

INFORMATION . . . Comprehensive brochures and catalogs are available to give you the complete scope of C/R products and services. Write for your copies, and please indicate your area of interest.

C/R

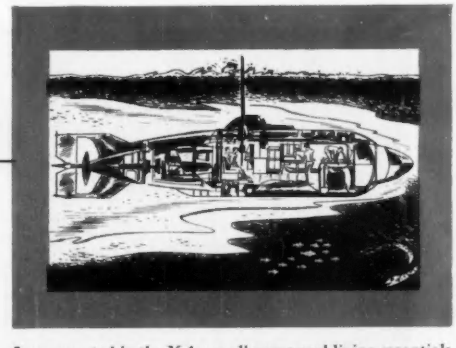
CHICAGO RAWHIDE

CHICAGO RAWHIDE MANUFACTURING COMPANY
1301 Elston Avenue, Chicago 22, Illinois
Offices in 55 principal cities

In Canada: Super Oil Seal Mfg. Co., Ltd., Hamilton, Ontario
Export Sales: Geon International Corp., Great Neck, New York

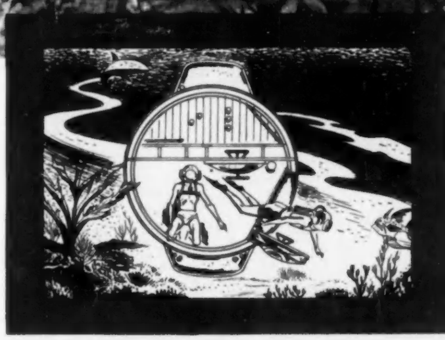
C/R Products
C/R Shaft & End Face Seals • Sirvene (synthetic rubber) molded pliable parts • Sirvis-Conpor mechanical leather cups, packings, boots • C/R Non-metallic Gears

PRIVATE EYE FOR THE U. S. NAVY



Incorporated in the X-1 are all personnel living essentials of larger subs. Crews are just as safe, just as comfortable, as those in large subs.

NUMBER 10 OF A SERIES



Because of its maneuverability in shallow water, and its agility in finding secure hiding places, the X-1 is a highly versatile addition to our Navy.

FAIRCHILD ENGINE DIVISION DESIGNED AND BUILT AMERICA'S FIRST MODERN MIDGET SUBMERSIBLE FOR THE U. S. NAVY

New tactical mobility is brought to many U.S. Navy operations by the Fairchild X-1, a revolutionary underwater weapons system for close-in reconnaissance of harbors and inlets. The X-1 is the first of its kind ever produced in America, and the first naval vessel of any kind to be designed and constructed by a U.S. aircraft manufacturer.

Fairchild designed and built the 25-ton, 50-foot X-1 with an unconventional underwater propulsion system, and with airplane-like controls. The new "pocket" sub has a four-man crew—operates quietly and stealthily, performing missions that large craft could never do.

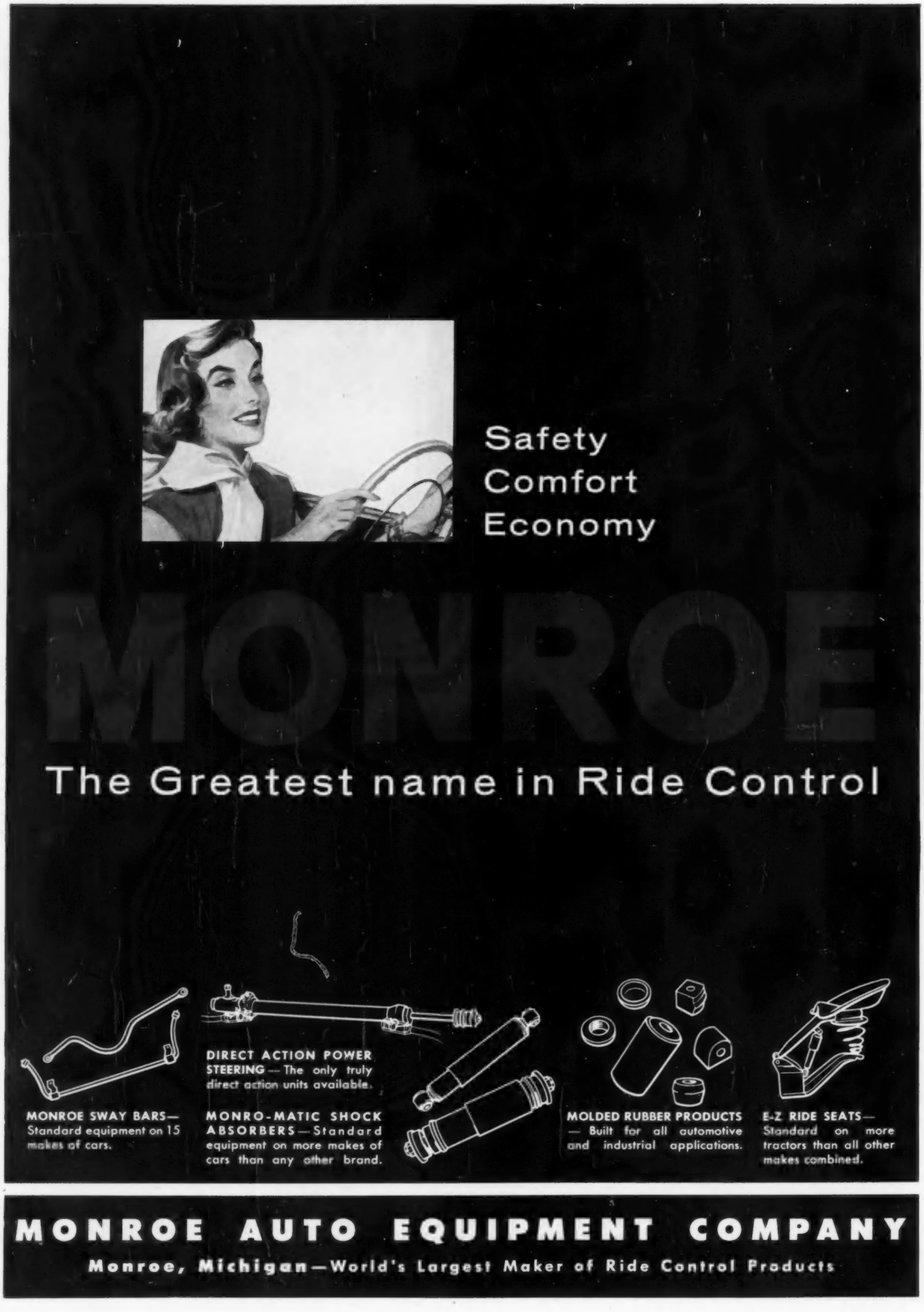
Once again, Fairchild design and engineering ingenuity has produced a vital new instrument of defense for our armed forces.

A Division of Fairchild Engine and Airplane Corporation

FAIRCHILD

ENGINE DIVISION • DEER PARK, L. I., N. Y.

...WHERE THE FUTURE IS MEASURED IN LIGHT-YEARS!



Safety
Comfort
Economy
MONROE
The Greatest name in Ride Control
MONROE SWAY BARS—Standard equipment on 15 makes of cars.
DIRECT ACTION POWER STEERING—The only truly direct action units available.
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MOLDED RUBBER PRODUCTS—Built for all automotive and industrial applications.
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MONROE AUTO EQUIPMENT COMPANY
Monroe, Michigan—World's Largest Maker of Ride Control Products

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PISTON RINGS

Since 1910, McQuay-Norris has played a leading role in the piston ring field. This background of more than 43 years experience is available to manufacturers who require engineering and production skills of the highest standard.

McQUAY-NORRIS MFG. CO. • ST. LOUIS 10, MO.

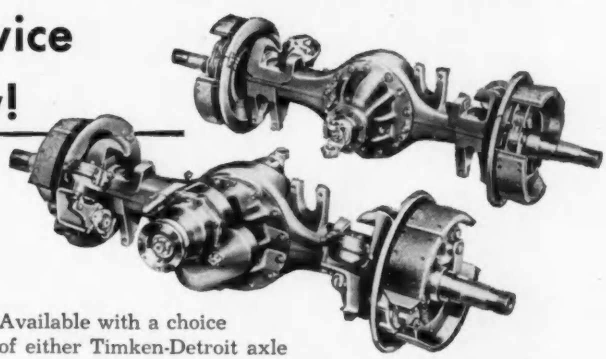
New TDA® lightweight

7,500 EXTRA TON-MILES

highway tandem gives

PAYLOAD A YEAR*

...built almost entirely from interchangeable standard axle parts for easier service and lower parts inventory!



This new lightweight tandem brings two important new advantages to highway freighters—greater payload capacity† and much easier maintenance.

More than two hundred pounds lighter than any other unit of the same capacity, this new TDA tandem will save a trucker 7,500 deadweight ton-miles during an average 75,000 mile year. This means more payload and profit where it counts.

Almost all of the parts—gears, pinions, differentials and brakes—used in this new tandem are interchangeable with parts from Timken-Detroit® standard single axles. This assures operators less down time . . . faster, simpler, more economical service . . . and smaller replacement parts inventory.

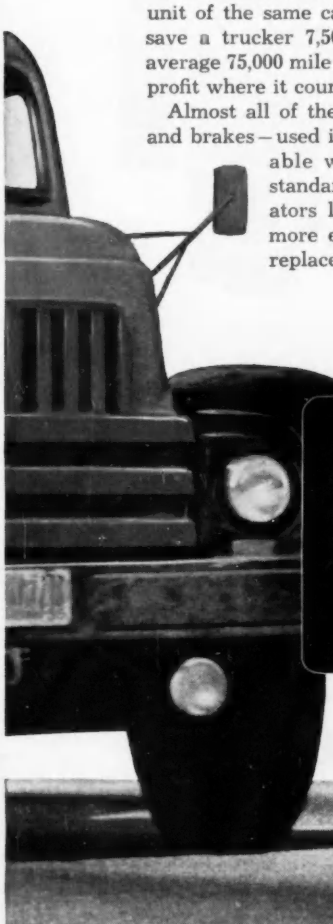
Available with a choice of either Timken-Detroit axle connecting groups, or brackets to accept other approved chassis hook-up parts. Plus these additional advantages with the Timken® lightweight tandem:

TDA Inter-Axle Differential Divides Torque Evenly Between Axles . . . and yet permits wheels of one axle to revolve faster or slower than wheels of the other axle. This means both axles are always doing equal amounts of work . . . driving parts and tires last longer.

Driver-Controlled Lockout—with TDA inter-axle differential, the driver can obtain the advantages of straight-through drive under slick or icy conditions by locking out the differential at *any* driving speed.

Big, Dependable Hypoid Gears rotate in conventional direction for maximum gear and bearing life.

This new highway tandem insures new payload profits, faster, easier service and operating economies for highway truckers everywhere. For complete information contact your nearest vehicle dealer or branch.



TIMKEN Detroit AXLES

TIMKEN-DETROIT AXLE DIVISION
ROCKWELL SPRING AND AXLE COMPANY
DETROIT 32, MICHIGAN

The Accepted TDA Standard
TRADE MARK REGISTERED

*based on 75,000 highway miles a year.
†for the same gross vehicle weight.

World's Largest Manufacturer of Axles for Trucks, Buses and Trailers

Plants at: Detroit, Michigan • Oshkosh, Wisconsin • Utica, New York • Ashtabula, Kenton and Newark, Ohio • New Castle, Pennsylvania

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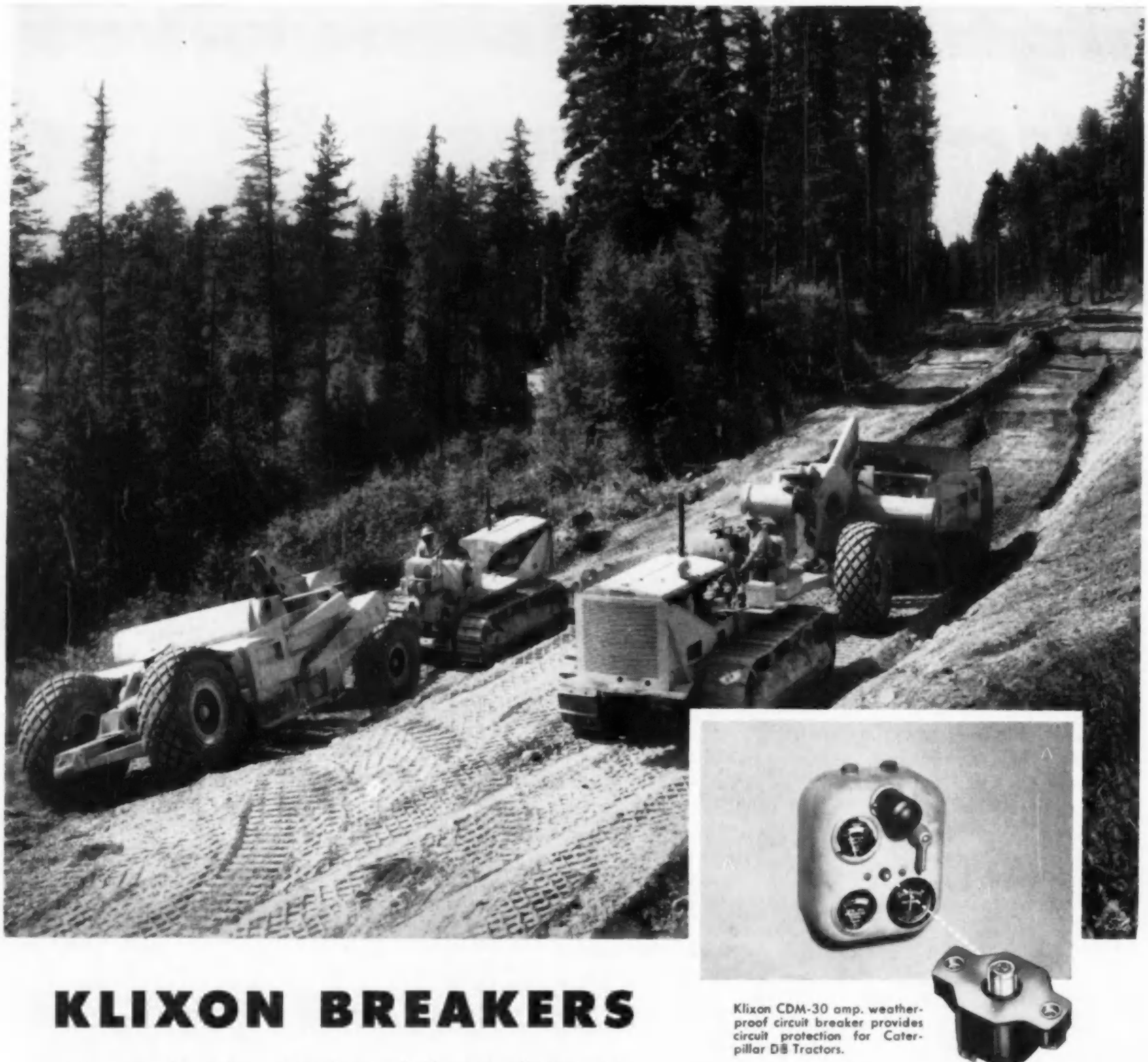


KLIXON BREAKERS

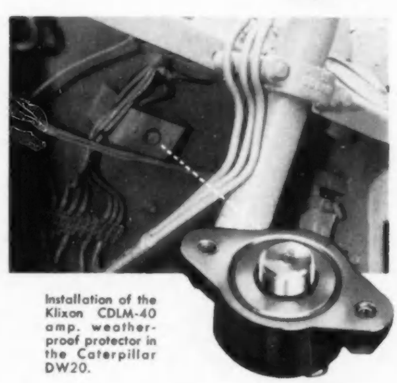
Assure Positive, Foolproof Electrical Circuit Protection in Famous Caterpillar Diesel Machinery

For years the famous Caterpillar-built products have been known as herculean workers which transform rough, tough terrains into gentle highways and byways.

Klixon weatherproof breakers are used to protect electrical circuits because experience has proved Klixon Breakers help keep Caterpillar Diesel Tractors operating even under extreme dust conditions.

No matter what type of mobile equipment you operate or how severe the operating conditions, it will pay for you to use Klixon Breakers for sure, permanent circuit protection in 6, 12, or 24 volt systems. Compact, they are easy to install. Their operation is unaffected by shock, motion, vibration, dust or moisture. Write for information.

Klixon CDM-30 amp. weatherproof circuit breaker provides circuit protection for Caterpillar D8 Tractors.



Installation of the Klixon CDLM-40 amp. weatherproof protector in the Caterpillar DW20.

KLIXON

TRADE MARK REG U S PAT OFF

METALS AND CONTROLS CORPORATION
SPENCER THERMOSTAT DIVISION
1501 Forest St., Attleboro, Mass.

For the Sake of Argument

The Successful Life . . .

By Norman G. Shidle

When you get right down to it—isn't a life successful when the man who lives it *knows* it is?

Ideas about what constitutes success differ as widely as costumes at a masked ball. So, manifestly, no one person can rely on the reactions of his friends and associates for a usable definition.

That means each must define for himself (probably by a somewhat mystic process that can best be called "knowing," rather than by purely intellectual processes). If a man in his heart really approves of himself, only the boldest meddler can question the successfulness of that man's life.

"Knowing," of course, can only be done by oneself, for oneself. It is unrelated to what we believe, what we say, or what we claim. Often the loudest claimant to success is but veneering an inner fear. The man who tries hardest to believe his life is being successfully lived, may, inside himself, be defining "faith" as "believing something you know isn't true." The man who says: "Yes, I think I'm living a successful life" may actually be "knowing" failure every day.

.... And what one man sees as failure, his neighbor may experience as a chance for progress—another small experience on the way to another big success.

We heard one man recently express his "this-I-believe" about success in these terms:

"The successful life is one which recognizes the existence of perfection and constantly *expects* to achieve it. The man who lives it sees *everything* as an opportunity to take a step in the right direction. He's happy to have the opportunity to go forward; never annoyed or frustrated because he hasn't arrived. . . .

"He constantly expects to reach his perfection goal and has found by experience that expectation speeds his progress."

EATON FEATURES reduce hauling costs, keep trucks on the job

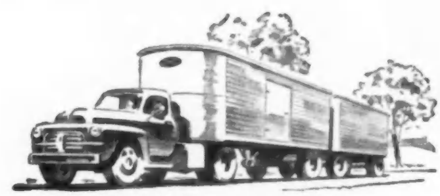
PLANETARY GEAR DESIGN—
distributes pressure and wear over four planetary gears, resulting in lower unit stress, reduced maintenance, longer axle life.

FORCED-FLOW LUBRICATING SYSTEM—
supplies positive lubrication to all moving axle parts, even at slowest vehicle speeds.

POSITIVE SHIFT CONTROL—
provides quick, easy shifts. Drivers use available gear ratios—the right ratio for road and load conditions.

SELF-CONTAINED AIR BRAKE—
provides for greater braking efficiency; quicker action, quicker release; quick, easy reline. Available on Eaton air brake models.

EXTRA-RUGGED CONSTRUCTION—
eliminates the possibility of harmful distortion or misalignment under full load, holds maintenance to a minimum.



More than Two Million
Eaton Axles in Trucks Today!

EATON 2-SPEED AXLES

EATON

AXLE DIVISION
MANUFACTURING COMPANY
CLEVELAND, OHIO

PRODUCTS: Sodium Cooled, Poppet, and Free Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Jet Engine Parts • Rotor Pumps • Motor Truck Axles • Permanent Mold Gray Iron Castings • Heater Defroster Units • Snap Rings Springtites • Spring Washers • Cold Drawn Steel • Stampings • Leaf and Coil Springs • Dynamatic Drives, Brakes, Dynamometers

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Contents—January, 1956

Society of Automotive Engineers, Inc.

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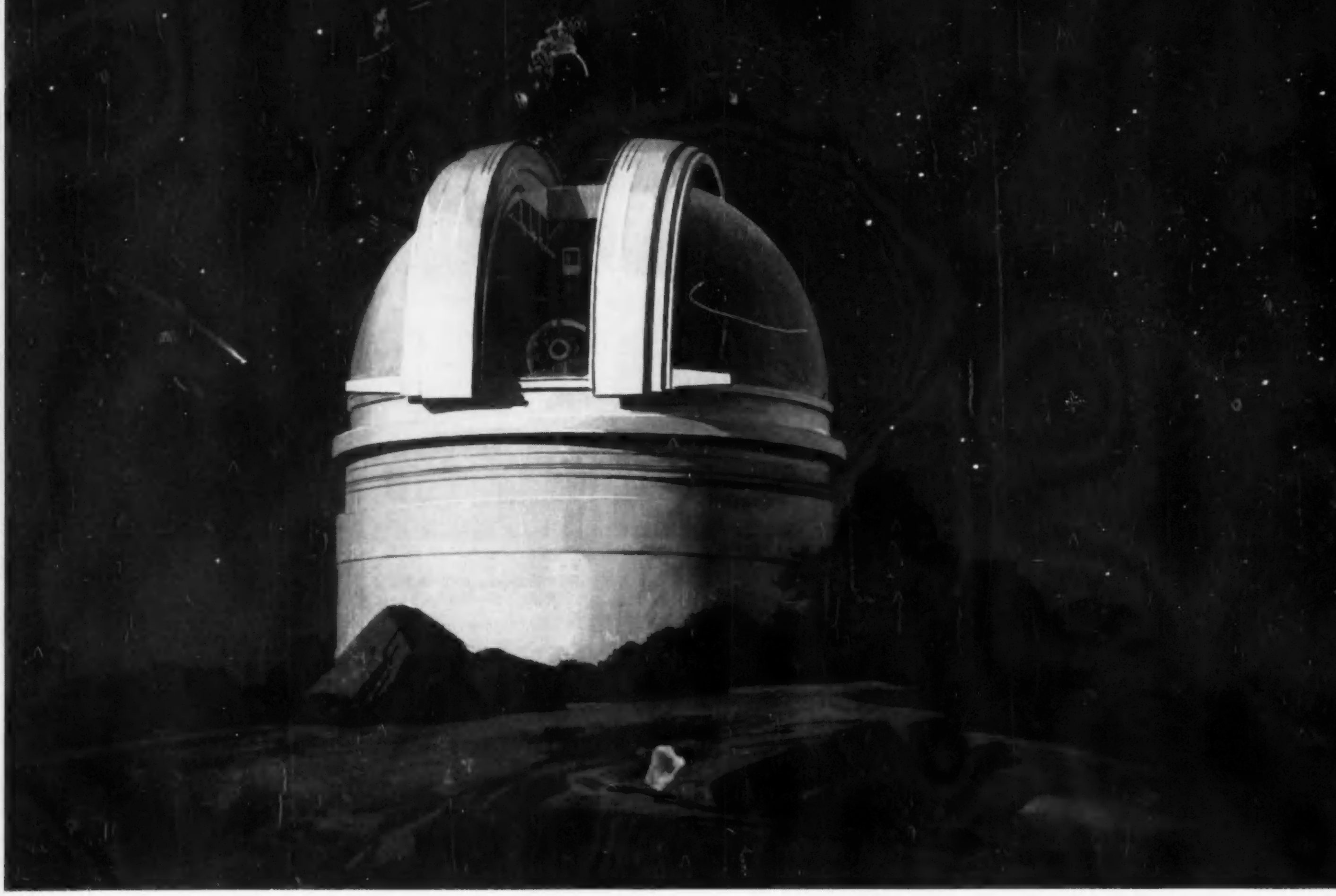

Planning for tomorrow • Producing for today!

Since the earliest days of the industry, Bendix foresight in product design and development has contributed materially to automotive progress.

For example, Bendix* power braking and power steering, two of the industry's most popular new car features, are the results of years of research and engineering by Bendix specialists in these important fields.

Today Bendix engineers are likewise busy planning and developing new and better products to meet the needs of the years ahead.

It is because of this foresight the automotive industry looks to Bendix for components that continue to lead in public acceptance and dependable performance.

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BENDIX PRODUCTS DIVISION **SOUTH BEND** INDIANA

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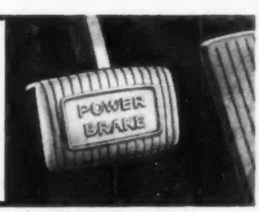
TYPICAL EXAMPLES



Bendix Power Brakes

Bendix Power Steering

Bendix Products Division

Bendix AVIATION CORPORATION

BRAKES • POWER STEERING • POWER BRAKING • CONSTANT VELOCITY UNIVERSAL JOINTS • HYDRAULIC REMOTE CONTROLS

The current permanent-looking shortage of engineers demands we seek, develop, and use all the good talents we can find, because our complex . . .

CIVILIZATION Can't Be Run By DOPES!

Lee A. DuBridge, president, California Institute of Technology

Excerpts from paper, "Science, Technology—and Men" presented at the SAE Golden Anniversary Aeronautic Meeting, Los Angeles, Oct. 14, 1955.

THE scarcity of intellectual talent which we are now facing will not be temporary. Our society will continually require more brains. Though there may be ups and downs in the supply and demand picture, the long-term trend is an increasing demand, while the supply clearly cannot continue to increase without limit.

This means we must:

(1) Find and encourage all the potential talent there is;

(2) Be sure that each individual receives educational opportunities commensurate with his ability;

(3) Continually seek means to avoid wasting talent by ineffective utilization.

These are large goals and they are not easy to reach. But they are not impossible and they are clearly worth reaching.

As long as:

- we are not helping each individual to find more quickly his proper place in the chain;
- our educational process misleads him or fail properly to prepare him for his proper function;
- large organizations fail to cope with the problems of teamwork, of chains of ideas . . .

. . . so long will men of potentially greater talent be inadequately used, and our precious intellectual resources thus reduced.

The time has passed when we can take it for granted that intellectual leaders will somehow spontaneously arise in adequate numbers to main-

A Challenge . . .

. . . is given to every automotive engineer by this provocative article.

Its challenge is equal, but different, for the young engineer and the veteran senior . . . for the engineer who still does straight engineering work and for the one whose job is now chiefly administrative . . . for those who want to get ahead and those who already have gotten there.

Each reader is likely to get from this article something different than the reader at the next desk . . . but Dr. DuBridge has a message for every one of us.

Dr. DuBridge Says . . .

"In 1953, there were about 633,000 who called themselves engineers, 361,000 of whom have college degrees."

"Even to double or treble our yield of technical talent, if possible, will certainly not be easy."

"If we try hard, we may be able in the next 25 years to change the attitude of parents, teachers, and the public so that they will encourage the study of scientific and technical subjects."

tain and advance the kind of civilization which we of the free world are trying to build.

We have built a civilization that has raised the common man to levels of comfort, and even luxury, that could not have been dreamed of a century ago. But this civilization requires a large supply of *uncommon* men to keep things going. **It cannot be run by dopes!**

The Few Build for The Many

The civilization of ancient Egypt was built by a handful of rulers, a few dozen engineers—and hundreds of thousands of peasant farmers and slave laborers. Modern American civilization is operated by a working force of about 60 million men and women (only one-fifth of whom are classed as unskilled laborers). About 40% of the workers are high school graduates and 7% have finished college, percentages which are both much higher in the younger age levels.

Moreover, some 5½ million men and women—nearly 10% of the working force—are classed as "professional, technical and kindred workers".

These are the people with the technical and managerial "know-how" who keep our economy going at present standards. In 1953 there were about 237,000 employed "scientists"—chemists, physicists, geologists and biologists. There were 185,000 practicing physicians.

There were about 633,000 who called themselves engineers, 361,000 of whom have college degrees.

Thus the "scientific segment" of our working force now numbers something like a million people—one out of every 60 workers.

But the point we must recognize is this: The fraction of the working population which must possess highly specialized talent and training has been rapidly increasing—and is certain to increase further. In a complex industrial society the talents of an ever-increasing percentage of the people will need to be devoted to solving the difficult problems of research, development, design, production, maintenance, management and control.

The heavy, routine and repetitious work of the world is going to be done more and more by automatic machines. The key figure of the future is not the frustrated automaton, but the man with his feet on his desk—thinking. That is something the machines will not do.

Indeed the machines will pose complex problems which will require more men to do more thinking. That is the one thing that is clear about the demands of a world that is seeking ever to progress. More and more men must be trained to think—must have their powers of thought developed and used to the utmost.

Are there enough human beings born each year with proper combination of genes and chromosomes such that they can ever learn to think? Especially are there enough to think new thoughts, obtain new ideas, uncover new knowledge, new truth?

Let us take, for example, the field of science. One hundred years ago a research scientist was a great rarity anywhere in the world. Was this a genetic limitation?

Obviously not! Because as scientific knowledge grew, as the tremendous possibilities in applied science became known, more and more people became interested in developing skills in these fields. More and more potential scientists appeared at the universities and set about training themselves in this new field. Today one man in every 300 of our working population classes himself as a professional *scientist;* in addition, 1 man in every 100 is an *engineer*.

Clearly then, some scientific or engineering aptitude is to be found in at least 1% of the American male population. Indeed, today out of all the men graduating each year from our colleges and universities nearly 20% take their degrees in science or engineering.

Yet it is quite clear that technical talent is a bit scarce. Not everyone is a potential engineer. We seem to have found that scientific talent occurs in 20% of the male college graduates, but that is still only 4% of the total male population of that age.

Even to double or treble our yield of technical talent, if possible, will certainly not be easy. Let us consider first our college population—the 1½ million or more young men now in our colleges and universities. We have already said that some 20% of them will go into science and engineering. What are the chances that this might rise to 40%? Per-

"Using every man to the maximum of his capabilities—week by week and year by year—is a terribly important goal which is worth great effort to achieve."

"At the very top level of intelligence we have serious wastage. Half the young people of top talent do not enter college and are lost to the professions."

"It is taken for granted that the function of an engineer is to bridge the gap between scientist and salesman. . . . But we now must realize that that is too wide a gap for one man to bridge. Hence, several different 'breeds' of engineers will be required."

sonally I think the chances are small in the foreseeable future.

It will be hard to proselyte from the attractions of law and business. Also the type of special ability in mathematics which is required of physical scientists and engineers seems to be just rare enough that only a small percentage are attracted by or will be successful in these subjects.

There are just too many people who "can't stand mathematics".

Is this a natural limitation? a genetic fact? Or is it because dislike of mathematics is drummed into our youngsters from the time they enter school?

American public schools bear a grave burden of proof if they are to show that they encourage all the natural talent for science and mathematics which appears in our youth. The boy who really likes math seldom dares brag about it—even to his advisers, who often tell him not to waste so much time on tough and "technical" courses; to take something "broadening" like "Social Adjustment".

If we try hard, we may be able in the next 25 or 50 years to change the attitudes of parents, teachers and the public so that they will encourage the study of scientific and technical subjects. We might then increase our yield of scientists from 20 to 40% of the college men graduates. But, for the present, I am inclined to think that we cannot hope to double our supply solely by trying to persuade a large fraction of those in college, or even in high school, to switch to science and engineering.

We must next face the fact that only 30% of our 18-year-olds each year even *enter* college. What happens to the other 70 percent? Is there a great wastage here?

Undoubtedly there is—though probably not as much as might appear at first sight. Granted, as I have said, that our measurements of intellectual capacity are not always accurate in individual cases, they still give us a fairly good statistical picture. And that picture shows the following:

(1) A large fraction (80%) of the college entrants and most (90%) of the college graduates are among the upper 50% of the population in intelligence. In other words, a large share of those who do *not* enter college probably could not meet the standards if they did enter.

(2) Nevertheless, if we look only at the upper 25% in intelligence (the group from which nearly all scientists and engineers come), we find that only 42% (or 3 out of 7) of them enter college. Of all college entrants, 50% are among the upper 25% in intelligence and two-thirds of college graduates are. Even among the top 10% we find that half are *not* in college.

Thus, at the very top level of intelligence we have serious wastage.

Half of the young people of top talent do not enter college and are lost to the professions. Here again is a task for our overloaded elementary teachers—to help *all* bright youngsters to want to continue their education. If they are bright and if they really want to continue, then the colleges can usually find a way to make it possible for them to find the financial means—except at the very lowest economic levels where the child's own earning power is needed by his family.

We see then that even with great effort we could just barely double the number of top-grade youngsters to go to college. There are just about that many!

In view of all this, I personally come to the conclusion, which I devoutly hope will prove wrong, that we should not expect to double the fraction of our young people who enter science and engineering during the next 20 years—provided we still maintain the present *qualitative standards.* We should work hard to try to achieve the doubling—we should try for at least a 20% increase. But as a nation we should plan on the assumption that the percentage will not rise sharply.

Does that sound a bit hopeless? No, not quite. There are a few things we have not yet considered.

The first is that the absolute number of American children reaching college age is going to show a rapid rise during coming years. Thus even if only the same fraction go to college and only the same fraction choose science, we still will nearly double our actual annual output of scientists and engineers by 1965. That is fine! It may indeed just about solve our problem of shortages. It *would*

"There are some colleges whose best students would be rejected by certain other institutions. . . . We ought to be a bit more frank and open about this business of the average intelligence level of each student body."

"We should not expect to double the fraction of our young people who enter science and engineering during the next 20 years—provided we still maintain the present qualitative standards."

solve the problem by 1965 if the present relative *demand* continues.

But suppose the relative demand also rises—as I am sure it will. Is there any hope we can keep up with it? Again the answer is the same as before: We might—with great effort—keep up, provided the relative demand (that is, the desired number per 1,000 population) does not rise too steeply.

My guess is that it will be a close race and we still have to keep on our toes every minute.

Can't Afford Talent Waste

Clearly, we can no longer afford to waste scientific talent—or any other kind of intellectual talent. Clearly we must stop the nonsense of putting trained scientists in the army to do "Squads right!" for two years. (Yes, I can give you names of good Caltech graduates who are doing just that.) It is not that I want special privileges for scientists; that I want to exempt them from serving their country. Quite the opposite! They should be required to serve their country *where they are most needed*—namely, as scientists or engineers. There are plenty of ways by which that could be achieved—but it will take some radically new thinking in certain political circles.

Clearly we should not waste talent in industry either. We should not put good engineers to work doing routine drafting or computing. I know of course that not *every* bright college graduate can be chief engineer the first year! He needs some routine duties now and then.

But using every man to the maximum of his capabilities—week by week and year by year—is a terribly important goal which is worth great effort to achieve. In industry, in government, in universities, this failure to use talent to its maximum is our most serious problem of manpower waste.

In the universities too we need to avoid wastage. We should make sure that each student receives an education which makes full use of his talents. But this raises a delicate question which universities often hesitate to discuss—namely, how the the student should choose his college. It is an undeniable fact that at certain colleges the average intellectual level is substantially above that of some others—as judged, say, by results of the examinations given by the College Entrance Examination Board.

There are some colleges whose best students would be rejected by certain other institutions. Presumably then, if a very bright student goes to a college of the former type he would have a pretty easy time of it. He would not be using his intellectual talents to their fullest at all. Every student should be able to find, among the dozen or 50 or 100 colleges to which he might go, the one that just suits his talents and interests.

We ought to be a bit more frank and open about this business of the average intelligence level of each student body. And each prospective student ought to be able to find out where he stands in his class before he enters, and be free to transfer easily if he has made a mistake.

I have a special concern for the men of the very highest talent—the men who will make the major advances in engineering and research, the major advances in understanding human problems, the problems of management of an industrial society.

This top talent is so precious that it should not be wasted in fighting unnecessary obstacles. It should be recognized at an early age; encouraged and not suppressed; brought into touch at every stage with challenging opportunities for development; and in the end given the freedom and support needed for maximum achievement.

It is normally taken for granted that it is the function of the engineer to bridge this gap between scientist and salesman. He is the one who converts a new discovery into a widely sold product.

But we must now realize that that is too wide a gap for one man to bridge—hence several different "breeds" of engineers will be required. There will be one class of engineer almost indistinguishable from the research physicist or chemist or biologist. A second class will carry on into the preliminary or bread-board embodiment. A third will be responsible for reliability and economy. A fourth will design production techniques and a fifth will look after customer appeal—whether that is achieved by more colors or fewer dollars.

The task of throwing five (maybe there are even more!) kinds of engineers together is a formidable one, to say the least. The task of helping each individual understand which kind of engineer he is may be even more difficult—since most men think they can bridge the whole span alone.

The task of the educator is still more impossible. He must decide whether to train more men who can be, say, type 3 engineers, and who will be properly instructed in how to work on either side with type 2 and type 4; or whether to train men more broadly so that every man is a type 1, 2, 3, 4, and 5 all rolled into one. I do not know which is the more impossible goal—but I am sure we should all be giving more attention to the problem.

For complete paper (in multilith form) on which this abridgment is based, write SAE Special Publications. Price: 35¢ to members, 60¢ to nonmembers.

USAF's C-130A HERCULES Packs 'em in

Capt. Richard D. Cousins, U. S. Air Force

Based on paper, "USAF Experience to Date with Turboprop Aircraft," presented at SAE Golden Anniversary Aeronautic Meeting, New York City, April 20, 1955.

LOCKHEED'S new C-130A Hercules provides the Air Force with a medium combat transport having remarkable loadability features:

- It can carry personnel, cargo, and heavy equipment with equal ease, make deliveries by air or on the ground.
- It is as easy to load as a highway van.

The C-130A can, for instance, be converted in a matter of minutes from cargo or equipment carrying to personnel carrying (up to 92 troops or 64 paratroops) or for evacuating the wounded. Combination loads of troops and vehicles can be accommodated. Moreover, any desired load combination can be provided, thanks to a multiplicity of high-strength tiedowns and a rugged cargo deck.

Loading mobile equipment consists merely in rolling it up the integral rear ramp and door and directly into the 9×10-ft loading compartment. A forward cargo door permits simultaneous loading or unloading from the other end of the cargo compartment.

The cargo floor is at truck-bed level (41 in. from the ground). The rear ramp at the level position makes an ideal loading dock for trucks. Roller conveyers allow quick transfer of cargo. Fork-lift loading or mechanized loading from dock or ground level can speed cargo handling.

In trials conducted by Tactical Air Command's 18th Air Force, heavy equipment loads included a rotary snow plow, an F-6 (5000 gal) fuel truck with tractor, a fire truck, a bulldozer, a truck-mounted crane, road graders, a 29-passenger bus, and a 155-mm howitzer. Guided missiles with launching platforms, many other types of mobile equipment, and a wide variety of cargo items were also quickly loaded and unloaded.

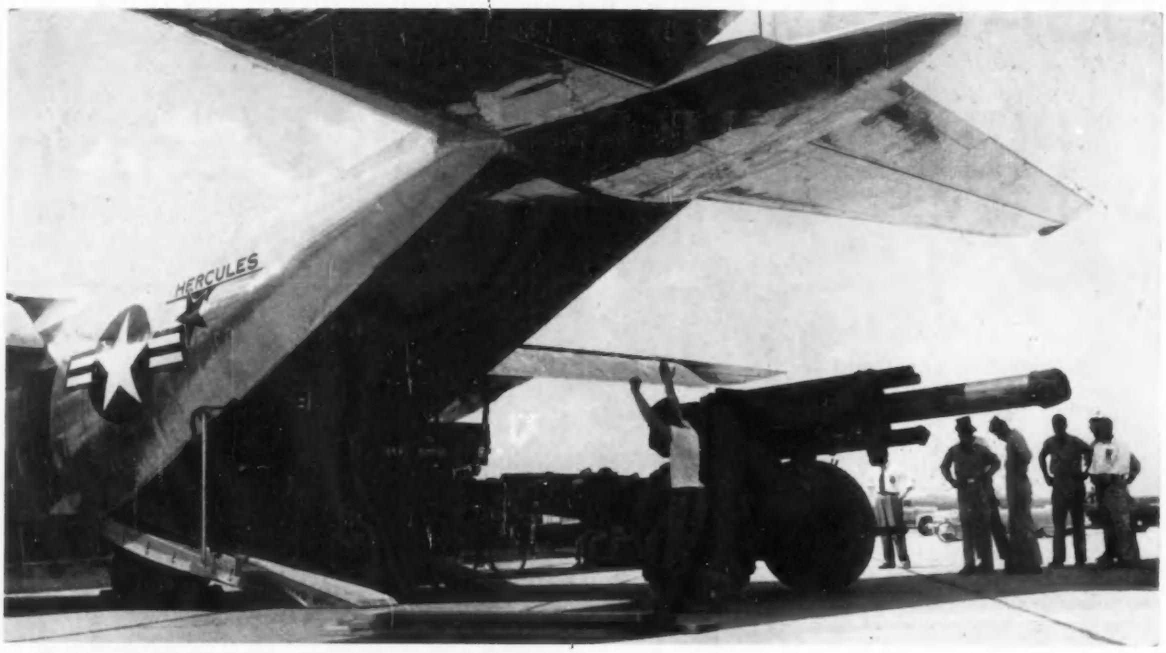
On this and the following pages some of these loadability features are illustrated.

Turn page→

Brief Fact Sheet for USAF C-130A Hercules

Wing Span, ft	132.6
Length, ft	95.2
Height, ft	38.3
Tread, ft	14.3
Design Load (L.F. = 3), lb	108,000
Normal Take-off Load (Max) (L.F. = 2.5), lb	110,500
Payload (Max), lb	40,000
Powerplant	Four Allison T56 Turboprops
Total Horsepower	15,000
Main Compartment Capacity, cu ft	3,680
Cargo Floor Capacity (on Treadway):	
Single Axle Load, lb	13,000
Single Wheel Load, lb	6,500
Density (Max), lb per sq ft	1,080
Ramp:	
Single Axle Load, lb	13,000
Single Wheel Load, lb	6,500
Loading Pulley, lb	25,000

. . . And Hauls Men and Cargo with Equal Ease



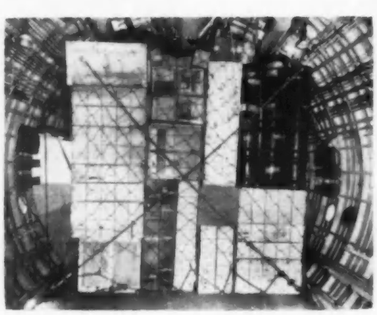
Above: Tractor pulling 6-ton 155-mm howitzer (the heaviest weapon used by an Army division) up integral ramp and into cargo compartment.

Left: Aircraft warning team, complete with truck, loaded aboard plane. Such loads can be delivered to forward areas by parachute drops or by landings on unprepared airstrips.

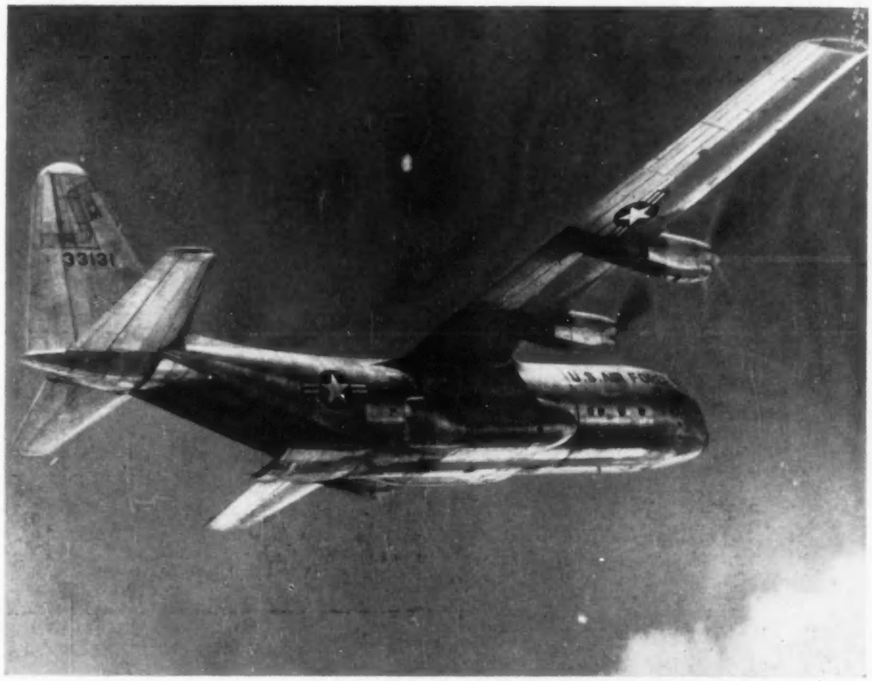
Lower left: Plane loaded with litter cases. After discharging its cargo in forward areas, plane can readily be converted to an aerial ambulance for evacuation of wounded personnel. Plane can accommodate 74 patients plus 2 attendants or 70 patients plus 6 attendants. Vertical spacing and angle of litter tiers are adjustable. Air conditioning provides maximum comfort for the wounded.

Lower center: Compartment loaded with miscellaneous cargo. Compartment is longer, wider, and higher than standard freight car.

Lower right: 5000-gal fuel tanker and tractor being loaded on plane.



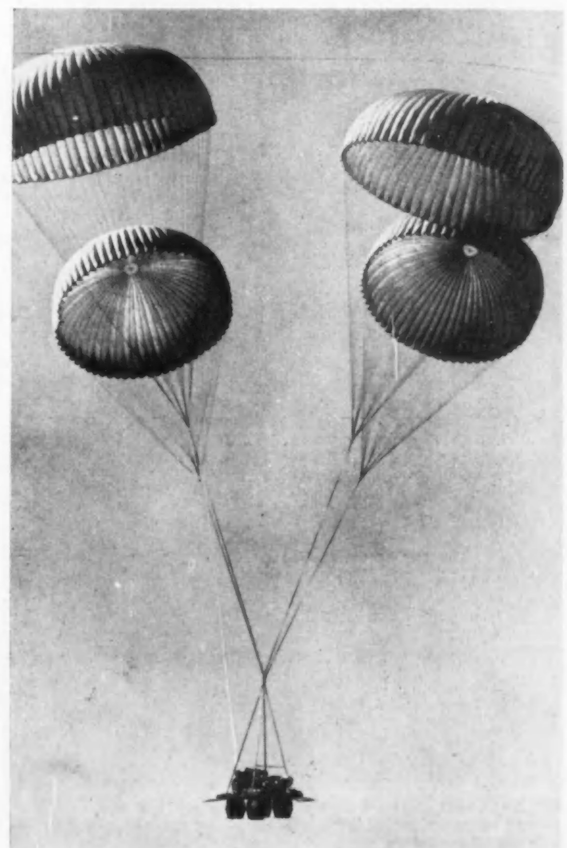
Air Delivery of Cargo Is Easy as One—Two—Three



1. Rear door is opened.

2. Pilot releases load from cockpit.

3. Platform with cargo leaves plane and parachutes to ground.



THE aerial delivery system used on the Hercules enables the pilot to drop tons of cargo to the ground within seconds.

Military vehicles, weapons, equipment, and supplies can be air-dropped by the system, using virtually any open space for the drop zone.

The system uses two aluminum-alloy platforms 9×24 and 9×15 ft, which have a gross capacity of 25,000 and 15,000 lb, respectively. Cargo up to a gross weight of 20 tons can thus be loaded and fastened to these platforms. Then these are loaded into the C-130A by roller conveyers.

The pilot, while the airplane is in flight, releases the platforms by pushing a button in the cockpit. This disconnects the first platform from the airplane and allows an extraction parachute to drag the loaded platform out the rear of the plane.

After the cargo-carrying pallet clears the airplane, an automatic mechanism opens several large 'chutes, which lower the load to the ground.

The second platform follows the first in a couple of seconds.

The system includes shock-absorbing devices to cushion the impact of the platform when it strikes the ground. A special mechanism also prevents the cargo-laden platform from being upset by rough terrain or drift caused by surface winds.

Both platforms and 'chutes are reusable.

Shown above is a plane with the rear door open, ready to drop the load. At the right, a 105-mm artillery piece is being lowered to the ground.

Computer Gadgetry Helps Solve

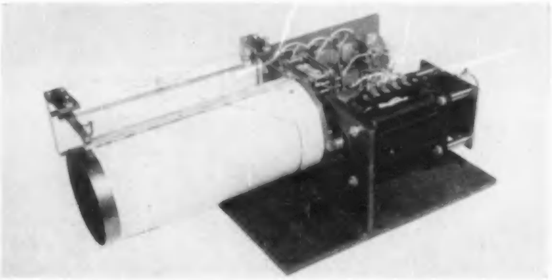


Fig. 1—The slide-wire resistor taps off a voltage proportional to the ordinate of the curve in this function generator device used with analog computers.

Fig. 2—Contact fingers translate the coding punched in a card into a voltage representing the curve ordinate in this function generator used with digital computers.

FORD uses the following accessories in conjunction with computer devices:

1. Slide-wire function generators
2. Punched card function generators, and
3. Coated glass flow line plotting

Both function generators are used in applications for which equations cannot be entered into the computer. For example, a slide-wire function generator may develop a variable voltage representing the forces on an automobile suspension system as caused by a bumpy road. This voltage is fed to an analog computer. As another example, a punched card function generator will develop variable voltages in accordance with cam profile in a valve gear test and feed these to a digital computer.

Coated glass flow line plotting offers a visual presentation of flow lines about an arbitrary shape. An example is the air flow lines about an automobile.

Slide-Wire Generator

A device used with analog computers consists of a curve, a rotating drum, and a slide-wire resistor. It develops variable voltages which simulate operating conditions. The curve to be introduced into the computer is drawn on a sheet of graph paper. A blue line copy is made. To this copy a piece of wire is carefully glued to follow the curve shape.

The paper-wire curve is then mounted on a drum as shown in Fig. 1. The drum has a servomotor for positioning. A slide-wire resistor is mounted parallel to the drum axis and held against the drum periphery by spring tension. Lowering the resistor into place against the drum completes the setup for operation.

A voltage is impressed across the slide-wire, the fraction tapped off by the curve-wire being proportional to the ordinate for that particular drum posi-

Special Problems

R. A. Roggenbuck, Section Supervisor, and
R. D. Jeska, Unit Supervisor, Ford Motor Co. Technical Service Dept.

Based on paper "Analog and Digital Computer Methods for Engineering Problems" presented at SAE Golden Anniversary Summer Meeting, Atlantic City, June 14, 1955.

tion. This voltage is then fed directly to the computer.

Punched Card Generator

A punched card, a rotating drum, and a set of contact fingers are the main components of a system used in conjunction with digital computers. This device eliminates the human error associated with the slide-wire generator. The curve is represented in this device by a card into which the ordinates of 80 points have been punched. The card is placed on a drum and rotated by a servomotor past a set of contact fingers. The fingers note the coding punched into the card, and translate this coding into a voltage representing the curve ordinate. Fig. 2 is a picture of this device.

The card is punched to an accuracy of one part in 256. Punched ordinates, however, produce a stepwise approximation for the curve, and for steep curves this too can result in considerable inaccuracy. A more accurate approximation by interpolation is being studied by Ford.

Flow Line Plotting

An analog computer developed at Ford to study flow patterns features:

1. A graphite-coated sheet of glass
2. An arbitrary shape for study
3. A plotting table

Fig. 3 is a picture of a sheet of glass coated with a thin uniform film of graphite. It is essentially a

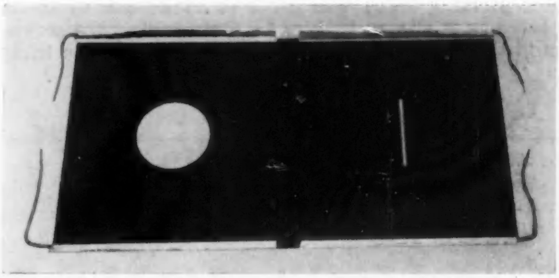


Fig. 3—This coated glass resistor is used in the study of flow lines. A voltage across the plate causes the equipotential lines to curve around arbitrary shapes painted on the plate.

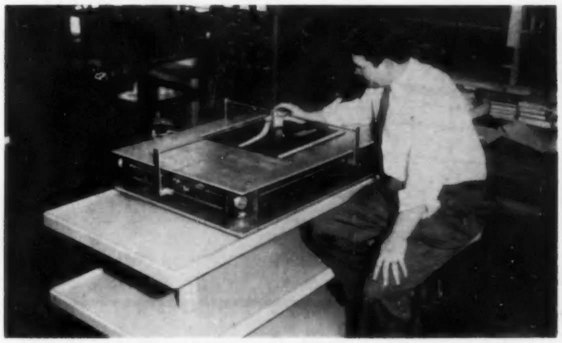


Fig. 4—A probe on this plotting table makes electrical contact on the carbon surface of a resistor plate. The moving probe describes the flow lines about any shape object.

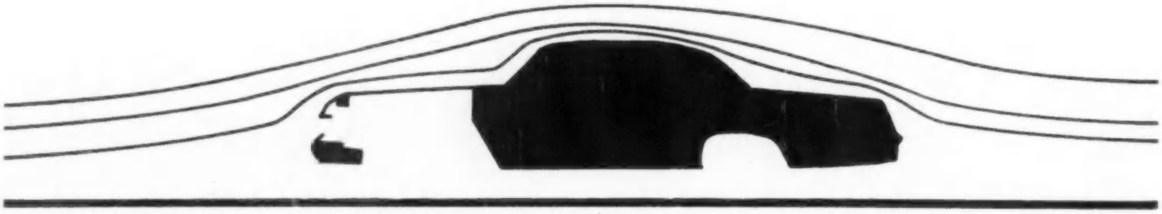


Fig. 5—Flow lines about the center section of a typical car appear here. This was described on a glass plate by the plotting probe.

large flat resistor. If electrodes are silver-painted on it at top and bottom, and a source of voltage connected to them, current will flow directly across from top to bottom. Since the resistivity is uniform in all directions, the equipotential lines will be at right angles to the current paths and parallel to each other. The equations which describe the shape of equipotential lines in an electrostatic field are the same as those which describe the path of flow lines in non-turbulent fluid flow, and the shape of the isothermal lines in heat flow. Thus it is possible to study one system by observing another acting under similar conditions.

If as in Fig. 3 some arbitrary shape is painted on in silver the current lines tend to enter this shape at right angles to the surface. This forces the equipotential lines to curve around the shape.

A plotting table was built to make use of these plates as is shown in Fig. 4. This table uses servomotor control on both the x and y axes. The table also has a carriage which holds a probe for making electrical contact on the carbon surface of the plate. This probe can be positioned to a particular equipotential line and, through controls, will maintain itself on that line.

This equipment can be used on many arbitrary shapes, and is especially useful in showing non-turbulent airflow patterns around a car body. Fig. 5 is a study of the center section of a typical car. The lower boundary electrode represents the road and the upper one represents a level sufficiently high that the air is not distributed by passage of the car. To go into finer detail as to airflow into the grill and radiator, requires only that an enlarged cross-section be prepared on another plate. Fig. 6 is a plot made from such an enlargement.

For complete paper (in multilith form) on which this abridgment is based, write SAE Special Publications. Price: 35¢ to members, 60¢ to nonmembers.

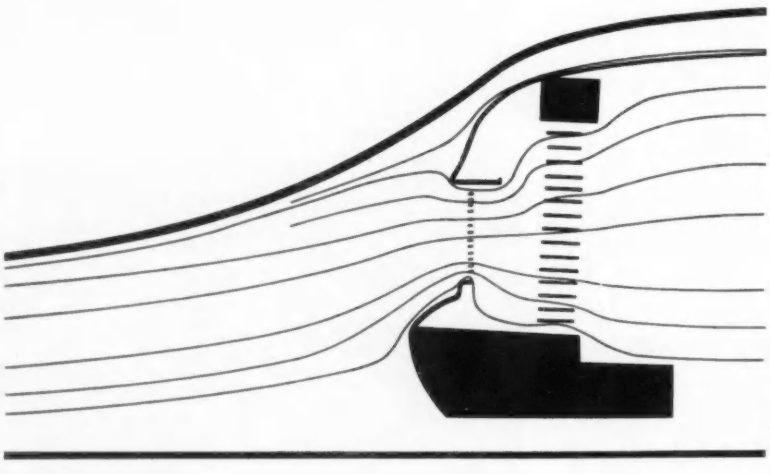


Fig. 6—The same technique can be used to describe the more complex flow of air into a grill and radiator of an automobile.

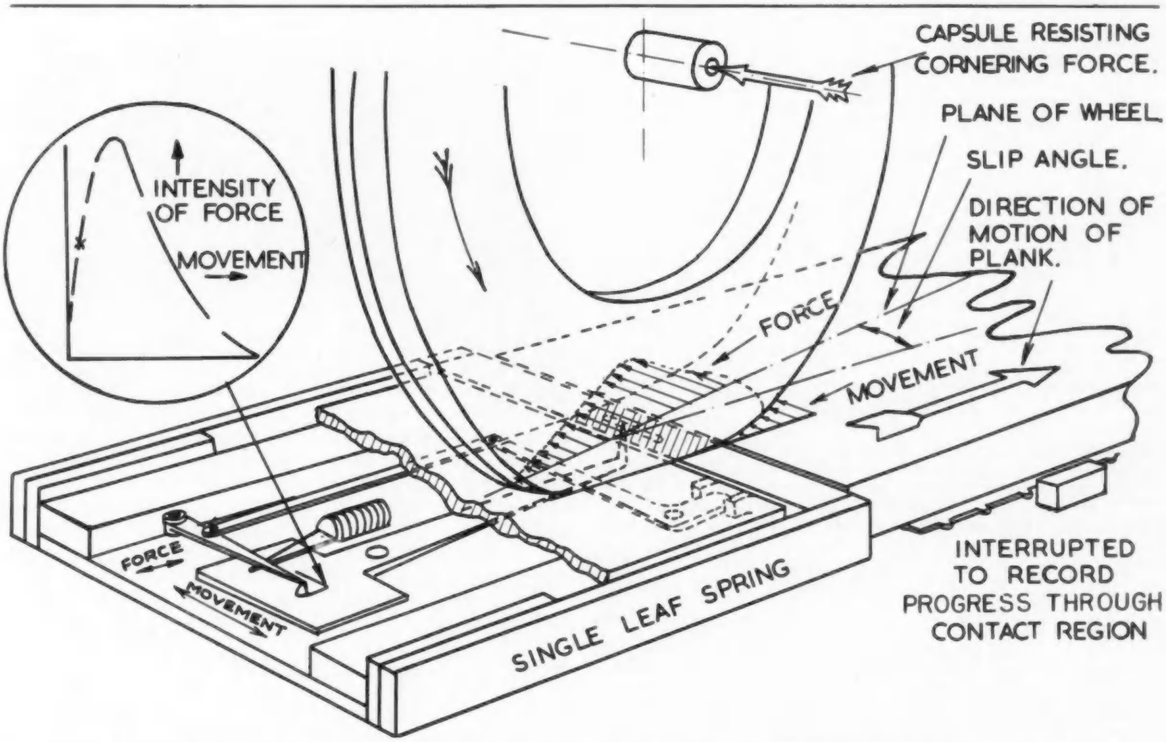


Fig 1—Apparatus for study of tire-ground lateral forces. The circle shows an enlarged portion of the curve traced out by the scriber: lateral movement versus lateral force.

CORNERING

can wear tires rapidly

V. E. Gough, Dunlop Rubber Co., Ltd.

Based on paper "Practical Tire Research" presented at the SAE Golden Anniversary Summer Meeting, Atlantic City, June 15, 1955.

BIG advantage of pneumatic tires is their ability to produce a large lateral force with only a relatively small slip angle from the free-rolling path (Figs. 1 and 2).

The degree of this cornering ability influences course stability and navigation of the vehicle and its "feel" or handling characteristics.

Experimental work shows also that cornering forces become a major factor influencing tread wear. In addition, the fact that abrasion occurs in the rear half of the tire-ground contact area has been confirmed, Fig. 2. In fact, under most operating conditions, lateral movements and forces predominate and cornering wear outweighs wear resulting from braking and driving. For example, a right-angle turn executed at a given speed and turn radius will result in a tread wear approximately equal to that produced by three full braking stops from the same speed in a distance of one-half the turn radius!

Cornering force is always present, though at times

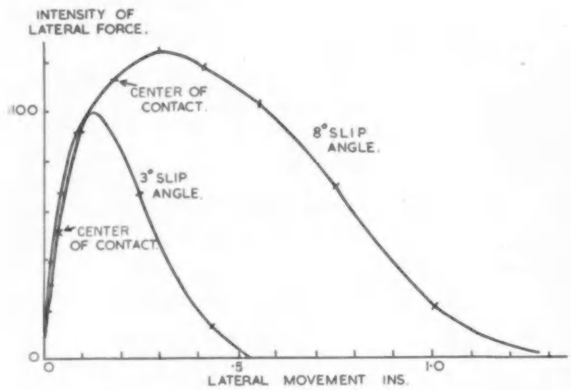


Fig. 2—Actual data obtained with the apparatus in Fig. 1. Note that the area under the curves represents work, and that for both values of slip angle, the major portion of the work is performed over the rear half of the tire-ground contact area. This correlates with the fact that most of the wear takes place over rear half of the tire contact area.

Fig. 4—Photograph of coarse texture wear on a tire continuously cornered for 32 miles at 8 mph. The wear resulting in normal braking or driving over the same distance is but a fraction of that observed here.

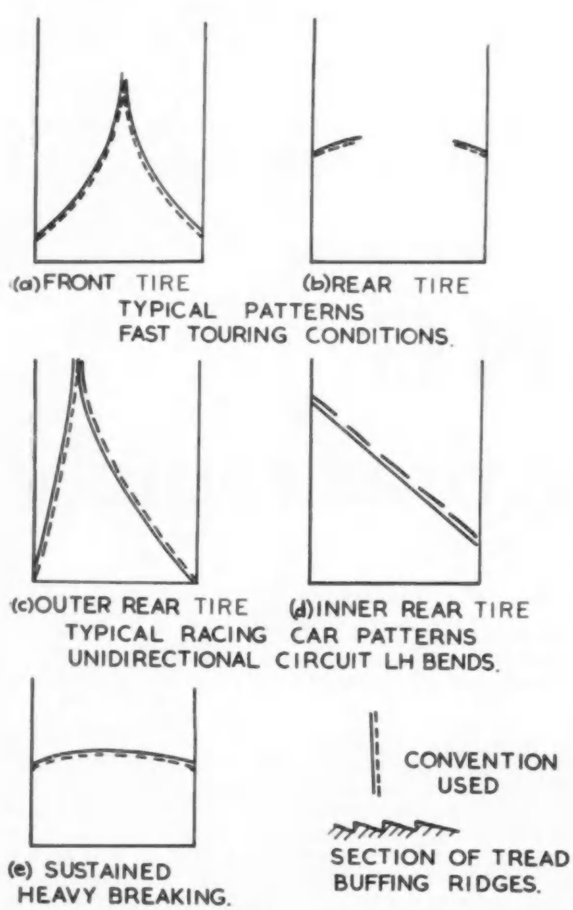


Fig. 3—Some typical wear conditions and patterns on tires. The tires are viewed as they move toward the observer.

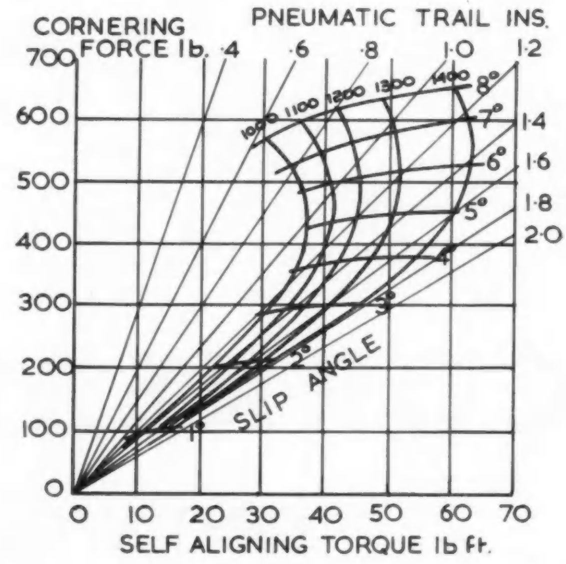


Fig. 5—A set of characteristic curves for a tire with a given inflation pressure.

it may be small. The mere presence of road camber or crosswind is enough to require the continuous application of slip angle for proper maneuvering.

Tread Wear Patterns

The local tire-ground movements depend a great deal on the overall slip during cornering. These movements are recorded as ridges in tread wear patterns which are plainly visible on rapidly worn treads. Since the ridges in the pattern are perpendicular to the movement between tire and ground,

the direction of the ridges enables us to infer the tire's history in use.

Typical wear patterns for tires in several positions on the vehicle and operated under different conditions are shown in Fig. 3. A photograph of actual ridges and an example of excessive cornering wear appears in Fig. 4. In general, the less sharp the ridges, the smoother and straighter the road, while a readily seen pattern indicates more rapid wear.

Characteristic Curves

In addition to their other uses, characteristic curves like those in Fig. 5 are a great help in studies of vehicle stability. For a given tire and operating conditions of slip angle and caster, the curves show the steering torque the driver applies against the cornering force produced. Note that under certain conditions of large slip angles and low caster, a rather large change in cornering force calls for no appreciable change in steering torque. This corresponds to a driver's loss of "feel" of the adjustment he must make in steering torque. This same loss of feel is experienced when the coefficient of friction between tire and road surface is reduced (Fig. 6).

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

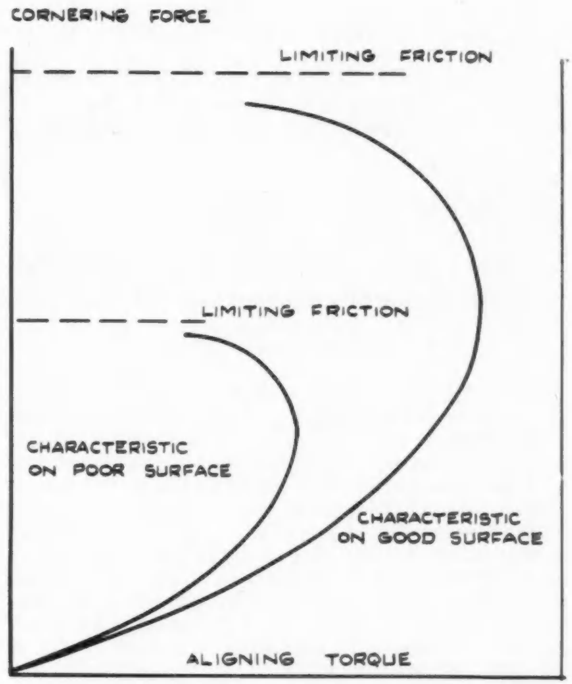


Fig. 6—The influence of limiting friction on the type characteristic curve. For a poor surface—one which has a low coefficient of friction with the tire—the shape is similar to that for a tire with a light load in Fig. 5.

Car Body Building . . .

. . . aided by centralized pilot program. Revisions are based on pre-production tryouts and tests. Heat from welding and paint ovens has unpredictable effect on body openings.

Based on secretary's report by **Edmond J. Beverly,** North American Aviation, Inc.

BEFORE a new automobile body model is put into mass production, it undergoes pre-production manufacturing tryouts and tests. This proves out the proposed new engineering, tooling, and processing methods.

The pilot plant is set up to include one of each production tool needed to perform all operations. The tools are used for the purpose and in the sequence specified by the process engineers. Then, on the basis of tool performance, changes are made in tool design, building sequence, fabricated parts, and product engineering.

The operational phase of the program begins in the trim fabricating plants. Trim sets are cut under prescribed production conditions, being run through sewing machines, embossing equipment, roll coaters, and molding fixtures as planned by the process engineers. Door and quarter foundations, headlining, seat bottoms and backs are assembled and screened carefully for possible correction in material, processing, or tooling requirements. Discrepancies are recorded and routed through proper channels for prompt elimination. Corrected trim sets are then shipped to the trim and final pilot program where they receive added checking on installation.

When the body building activities commence, subassemblies are constructed in production fixtures in planned sequence and with proper tooling. During this initial stage, only those corrections needed to permit assembly to go ahead are made. And this procedure is followed through all subsequent operations on the first body.

After welding and prior to metal finish, a very close check is made of all openings and surfaces. On the basis of this check corrective action is requested on parts, engineering drawings, assembly plant fixtures and fabricating plant dies. Using the body check as a guide, fixtures are adjusted and a second body is run through the building and checking operations.

Discrepancies will occur even under ideal conditions. And conditions are never ideal in body building. There are too many intangibles. Chief among them is the effect of heat on body build. It is almost impossible to determine in the design stage the effect that heat from gas and arc welding, tinning and soldering, and from paint ovens, will have on body openings.

(This article is based on the secretary's report of panel on "Controlled Economical Tooling and Shop Methods" held at SAE Golden Anniversary Produc-

tion Meeting, Cincinnati, March 14, 1955. Leader of the Panel was Glenn W. Periman, North American Aviation, Inc.; secretary was Edmond J. Beverly, North American Aviation, Inc. Panel members were: E. A. Brezina, Cleveland Twist Drill Co.; George D. Brimble, McDonnell Aircraft Corp.; L. E. Hall, Reynolds Metal Co.; Paul Joseph, Columbus Belt and Forge Co.; John Schachinger, General Motors Corp. This report together with seven other panel reports are available as SP-310 from SAE Special Publications Dept. Price: $1.50 to members, $3.00 to nonmembers.)

Safety Clutches . . .

. . . for tractor power take-off drives leave much to be desired. New device shows marked improvement over earlier types, but challenge is still on.

Based on paper by **Sherman C. Heth,** J. I. Case Co.

A POWER line safety device invented by L. R. Clausen, which the J. I. Case Co. has developed and tested, is apparently the closest approach yet made to a mechanical device capable of producing a torque-time curve whose limited maximum values form a straight horizontal line (see Fig. 1).

The device depends for its action on a torque spring, designed for a very small torsional spring rate, which causes the axially movable clutch component to advance into clutch face contact by rotation in respect to a very fine pitch cam surface. A schematic drawing of the clutch is shown in Fig. 2. To date, no specific application has appeared for which the advantages to be gained from improved clutch action outweight, or even balance, the additional cost of the design.

Until a few years ago, power take-off driven implements were protected by spring-loaded jaw clutches of the audible warning type. These were frequently combined or used in conjunction with overrunning devices on driven machines having moving parts of high inertia energy. By their very nature they were not very durable. The inclined slipping and impacting plane surfaces wear and change their slip characteristics rapidly. Generally, they have to be lubricated to prolong life for a reasonable duration, and any more than very short and infrequent slippage throws or burns off the lubricant, exposing the clutch to rapid damage, freezing, and tremendous increase of torque-carrying capacity.

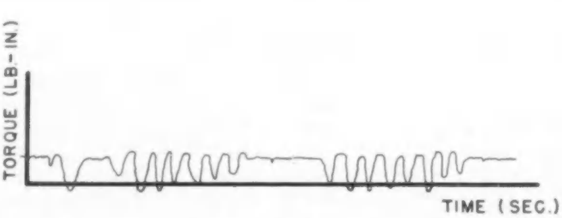


Fig. 1—Torque-time curve of the Clausen safety clutch for tractor power take-off drives.

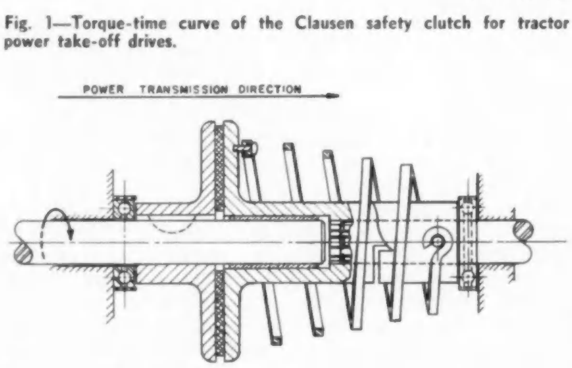
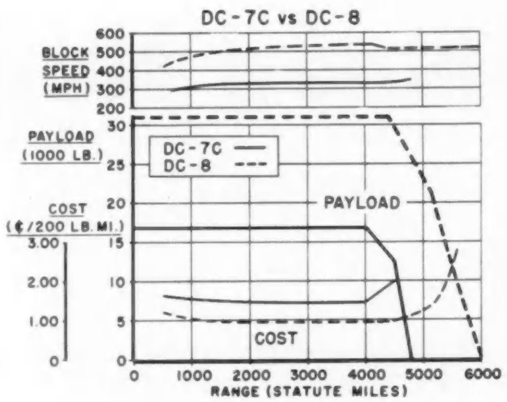


Fig. 2—Schematic illustration of the Clausen safety clutch. Action depends on torque spring which causes the axially movable component to advance into clutch face contact by rotation in respect to a very fine pitch cam surface.

The deficiencies of spring loaded jaw clutches led to the development of friction slip clutches and the change-over was accelerated by the introduction of such machines as power take-off driven hay balers and flywheel type forage harvesters. These machines develop extremely high momentary torques and require average torques considerably in excess of most of the previously used power take-off driven machines. The inertia values of the rotating parts of the implement are such that starting torques, when the clutch is engaged, rise to peaks far in excess of the average maximum available engine torque. Rotating parts tend to enter into resonance with the pulsations of the rotating parts of the tractor, such as the flywheel, resulting in tremendously high peaks in torque, sometimes cycling at relatively high frequencies.

Friction clutches prove very effective in cutting off sharp momentary peak torque loads while maintaining effective driving torque for normal operation. While the friction clutch represents a decided improvement over the jaw clutch as a safety device and load cushioner, it is possible that an unfortunate combination of clutch design and machine torque load requirements will cause excessive clutch slippage, entailing wear and temperature increases which may alter the clutch torque-transmitting characteristic, or "freeze up" the clutch entirely. In addition, friction clutches under dynamic conditions are found to transmit instantaneous torque loads which are two to three times as great as their static torque capacities. This factor makes clutch design uncertain and performance more erratic than could be hoped. Thus, there remains the challenge of further improvement. (Paper "Development of Safety Clutch for Tractor P.T.O. Drives" was presented at SAE Golden Anniversary Tractor Meeting, Milwaukee, Sept. 15, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

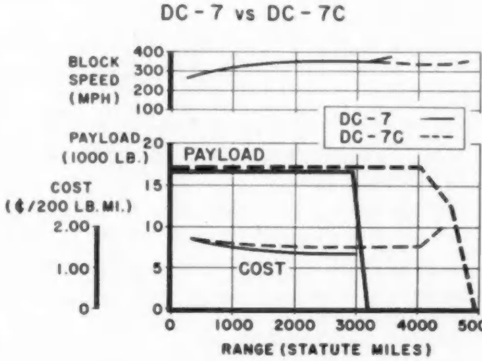
The DC-8 Jet Transport . . .

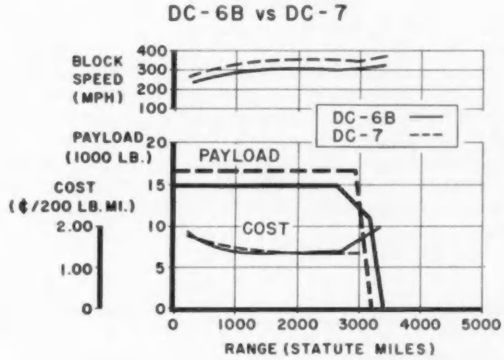


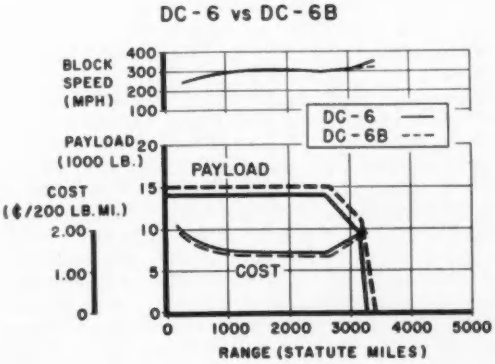
. . . will have greater economic advantage to airline operators than the DC-7C and any of its other predecessors in the Douglas DC transport series. This prediction was made by A. E. Raymond, vice-president of engineering for Douglas Aircraft Co., Inc. in a paper he presented at the SAE Golden Anniversary Aeronautic Meeting, Oct. 13, 1955 at Los Angeles.

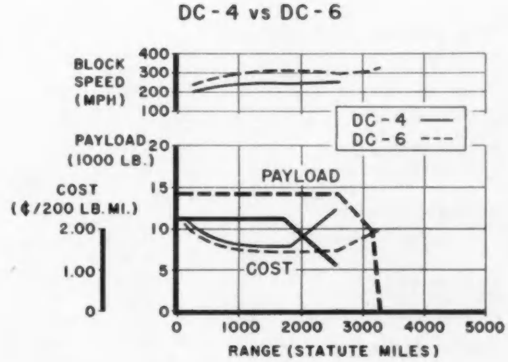
These charts show how the DC-8 and its ancestors compare, back as far as the DC-4. Each design, as it came along, offered advantages over the one before. Likewise, the DC-4 had more favorable characteristics than the DC-3, and the DC-3 was an improvement over the DC-2 and the DC-1.

Similar charts on page 37 of the November SAE Journal bore incorrect labels on the cost in ¢ per 200 lb-mile scale.









Airlines Need New

AIRCRAFT designed to give efficient operation over stage lengths of less than 80 miles are needed right now. Modified DC-3's and comparable pre-World War II aircraft do not meet local service carrier requirements. Twin-engined helicopters promise to provide the ultimate answer, but until they are available, which may be 10 years from now, new transports are needed which overcome the limitations of existing aircraft.

The immediacy of this need should be stated in terms of potential for short-haul air transportation rather than in terms of currently evidenced demand. The potential is great. In 1954, the airline share of the up-to-250 mile common carrier market of an estimated 438,000,000 passengers was only 2.25%. The market exists, but the aircraft to serve it are lacking, consequently there is a lot of work to be done.

ON THE PANEL which developed the information in this article were:

Leslie O. Barnes, panel chairman
Allegheny Airlines

R. G. Dinning, panel secretary
Allegheny Airlines

Frank W. Fink
Convair Division, General Dynamics Corp.

Robert E. Peach
Mohawk Airlines

Frank N. Piasecki
Piasecki Helicopter Corp.
(now with Piasecki Aircraft Corp.)

Curt G. Talbot
National Business Aircraft Association

Walter Tydon
Fairchild Engine Division, Fairchild Engine & Airplane Corp.

The DC-3 has seven basic limitations:

1. Cabin space limits seating capacity.
2. Weight and balance characteristics prevent full utilization of available baggage and cargo space.
3. There is insufficient power for rapid climb to altitude.
4. Attributes of a "clean" airplane, such as flush riveting and fully retractable landing gear, are lacking.
5. De-icing equipment is inadequate.
6. Slanting cabin floor slows passenger movement at ground stops.
7. Old age brings such problems as metal fatigue, vibration, and unnecessary weight.

Because of these limitations it has been necessary to augment DC-3 operations on high-demand, local-service route segments with aircraft such as the Convair 240 and Martin 202 with passenger capacity of 40 to 44. The disparity between maximum gross take-off weight and maximum allowable landing weight, however, imposes limitations on the use of the full load-carrying capacity of these aircraft systemwide because of limited local service stage lengths. In short, they do not permit effective penetration of the higher-volume, shorter-distance travel market.

While it is thought that twin-engined transport helicopters of 35-to-40-passenger capacity will play an important role in the future of short-haul transportation, that time may be 10 years off. Mohawk Airlines, after operating an S-55 in scheduled service and achieving operating costs of $1.60 per mile, has concluded that the helicopter will turn out to be the eventual effective short-haul inter-city transport. As the result of this experience it believes the major obstacle to operation of multi-engine helicopters will be community resistance to downtown heliports of adequate size, a resistance to be overcome only by extensive public education.

The basic advantage of the helicopter for short-haul transportation lies in its saving in airport to

R. G. Dinning, Allegheny Airlines

Based on secretary's report of Round Table on "Short-Haul Transports" held as part of the SAE Aeronautic Production Forum, at the SAE Golden Anniversary Aeronautic Meeting, New York, April 19, 1955.

Short-Haul Aircraft Now

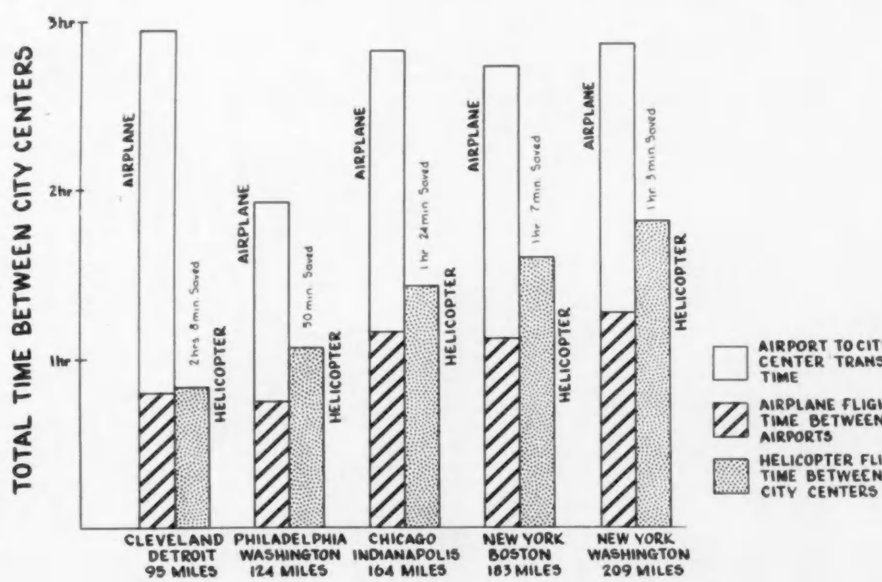
They can't wait for unborn helicopters

city-center transit time. Helicopters must and can have the following functional characteristics:

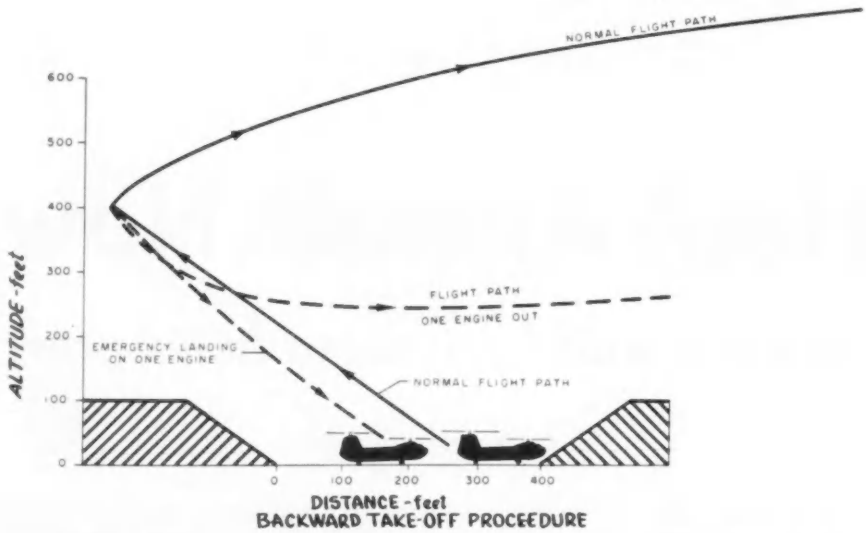
- Speed (in terms of total travel time)
- Safety in all weather conditions
- Convenience (close-in operations and passenger handling)
- Reasonably Low Fare (differential proportionate to time savings)
- Regularity and Punctuality
- Comfort (meet existing air travel standards)

Determination of the necessary size of landing facilities is of basic importance in the development of the helicopter because of the relationship between size and safety requirements. Special techniques, such as a backward take-off, may be utilized in order to operate out of 400-ft heliports. As a matter of fact, in view of the economics involved in the provision of suitable heliports, manufacturers must assume that 400 ft will be the maximum length of a heliport and meet this requirement.

Until suitable helicopters are available, local service airlines will have to depend upon the manufacturers' ability to modify aircraft like the Convair 240 or 340 to carry more passengers shorter distances if they wish to attain a subsidy-free status. The only alternative is for manufacturers to produce new transports which overcome present limitations.



HELICOPTERS could save appreciable travel time, city center to city center, over fixed-wing aircraft on many intercity routes.

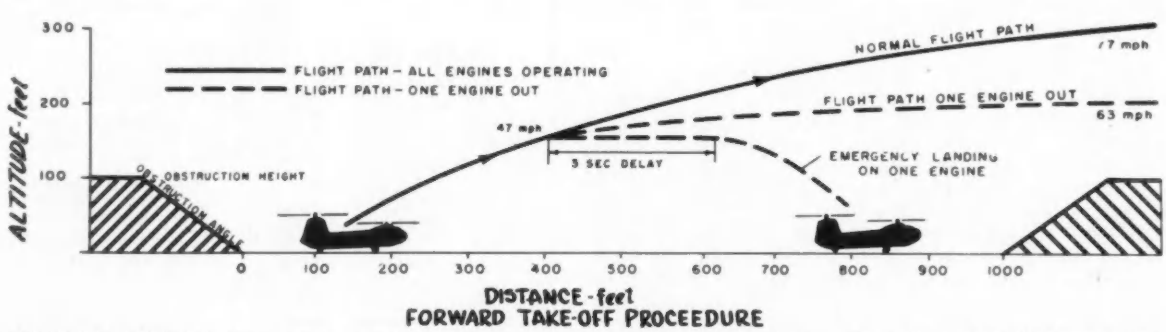


A REARWARD TAKE-OFF technique might permit twin-engined helicopters to operate out of 400-ft-runway airports.

Statements as to the requirements for short-haul transports vary widely and the problem of tailoring aircraft to these requirements is primarily one of cost. Convair maintains that its basic model 240 can be simplified without re-engineering, modified, and sold at a price appropriate for local service carriers. A study made by Convair on the use of this model for a typical local service airline brought forth these data:

Average trip length	86 miles
Block speed	166 mph
Utilization (revenue hours per day)	5.5 hr
Total distance flown per day	2512 miles
Aircraft required	2.25
Direct operating cost	81.5¢ per mile
Total operating cost (twice direct)	163¢ per mile
Revenue rate (total ton-miles flown)	103¢ per ton-mile
Break-even payload	1.58 tons
Break-even load composition:	
Passengers (at 160 lb plus 30 lb baggage)	15.5 passengers
Cargo	216 lb

When and if new short-haul transports are developed, the military should be taken into account. The military once depended upon commercial designs for its transports. Today, the reverse is true. Expansion of military air transportation has led to a large number of transport designs which will eventually come into the field of commercial operations.



FORWARD TAKE-OFF technique requires longer runways than rearward technique, for twin-engined helicopters designed to C.A.R. 06.

Furthermore, with the military putting greater emphasis on new transport types, the transport field will likely become completely standardized as to types in the near future. What is needed then is closer coordination between the military and the CAA on requirements and equipment, and CAA certification concurrent with military flight evaluation.

With the firming up of the larger type transport field, military emphasis is being channeled toward the smaller assault and utility types of transport. And just as there were reasons for differentiating between the purely cargo and the special or personnel type among large transports, so will there be a need, and a greater one, for differentiation in the utility or short-haul field. This calls for prompt recognition that passenger and cargo types must be kept in separate categories, both as to design features and regulations.

Use of aircraft for business flying is expanding rapidly and suitable transports are needed. The principal difference between specifications for needed "business" and local service transport types is to be found in short field requirements, passenger capacity, and minimum range. A study made by the National Business Aircraft Association to determine utilization of large transport aircraft in business flying reveals 450 miles to be the average range of all flights being made, 1150 miles to be the average maximum range, and the average utilization per year to be 596 hours.

(The report on which this article is based is available in full in multilith form together with reports of six other panel sessions of the 1955 SAE Production Forum held at the SAE Golden Anniversary Aeronautic Meeting, New York, April 19, 1955. This publication, SP-311, is available from SAE Special Publication Department. Price: $1.50 to members, $3.00 to nonmembers.)

Specifications for a business transport as drawn up by the National Business Aircraft Association

1. Passenger capacity—8 (10-place).
2. Cruising speed—300 mph minimum, using 60% METO (maximum except take-off) power.
3. Range at 60% METO—1250 miles plus reserve (full passenger and baggage load).
4. Ceiling, single engine—15,000 ft or more.
5. Land and take-off on sod fields over 50-ft obstacle in 2500 ft without reversing propeller.
6. Cabin headroom—74 in. minimum.
7. Cabin pressurization to maintain 5000 ft at 20,000 ft altitude.
8. Cockpit size—not less than DC-3.
9. Bird-proof windshields.
10. Maximum cockpit visibility.
11. Fire warning and extinguishing system equivalent to or better than in airliners.
12. Complete de-icing equipment of thermal, liquid, or thermal boot type.
13. Temperature-controlled electronic equipment compartment adequate in size and completely wired for all new and foreseeable equipment.
14. Completely accessible engine nacelles for ease of maintenance, permitting engine change in 1 hr maximum.
15. Integral auxiliary power unit.
16. Provisions for heating engine compartments with aircraft heating system to facilitate cold weather starting.
17. Tricycle landing gear with steerable nose wheel and dual main wheels with automatic braking.
18. Cabin features to include quickly removable seats, adjustable spacing with minimum of 48 in., floor stressed for moderate cargo loading, lavatory, and windows 15 in. square or larger.
19. Baggage capacity—600 lb with at least part accessible in flight. Loading must be either from ground or cab.
20. Integral entrance ramp.
21. External fuel tanks on or as near to wing tips as possible, or tanks in extreme outboard part of wing, or both. No fuel to be carried in wing center section or cabin. External tanks should be quickly removable so that oversize tanks can be used with reduced passenger loads. External tank mount design should provide for automatic release of tank in case of sudden deceleration. All fuel tanks to be equipped for quick dumping by manual control from cockpit.
22. Hangar requirements—same as for DC-3. If vertical stabilizer height is greater than on DC-3, automatic nose wheel jacking should be provided.

Making automobile bodies of fibrous-glass reinforced plastics is still an infant industry. Some ABC's—fundamental knowledge as it exists today—are discussed by experts in the following . . .

Primer for

HOW to make the best use of fibrous-glass reinforced plastic in the automobile industry is still problematical. Although the new material is superior to steel for certain uses, there are many variables—such as thickness, relative weight, glass content, and type of resin in a laminate—which must be decided before a designer can specify its use. He needs more fundamental knowledge of the chemical behavior of FGRP, more information about molding processes, and more data about how reinforced plastic stands up under tests and in service. Too, he must be cognizant of the costs of materials, labor, tooling, and manufacturing.

Here is the latest available information about this new material from plastics manufacturers and users in the automobile industry.

Polyester resins are most widely used

There are two broad classes of resins: thermoplastic and thermosetting. Thermoplastic resins simply soften when heated, undergoing no chemical change. They can be forced into dies while hot, molded, and then quickly cooled in place. Thermosetting resins undergo a chemical reaction when heated or cured. They become infusible. Molded parts can be removed from a die while still at curing temperature. Polyesters are thermosetting.

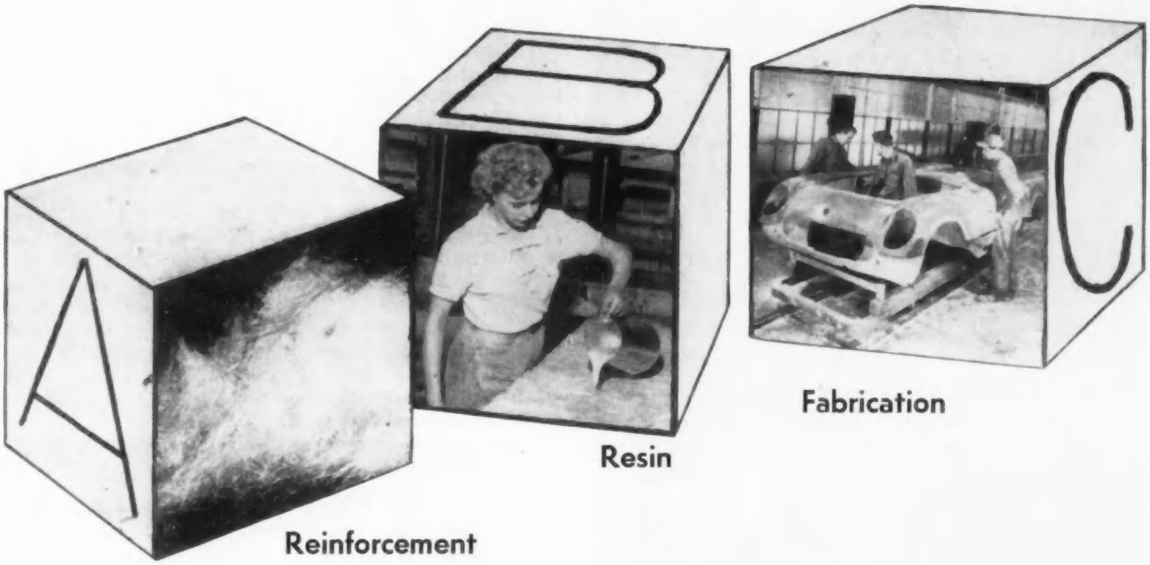
A polyester in the reinforced plastics field refers to an unsaturated, polyester-base resin dissolved in a polymerizable monomer (usually styrene). This combination is a clear liquid which can have a wide range of viscosity. Polymerization, or curing, is brought about by adding a catalyst just before the polyester is used. This causes the base resin and the monomer to copolymerize and make a thermoset material.

The base resin component of polyesters can be made from innumerable chemical combinations. Essentially dibasic acids and dihydric alcohols (glycols) are heated until they split out water and form chemical ester linkages. When the reaction proceeds to form many ester linkages in one linear molecule, the result is a polyester. At least a certain portion of the dibasic acids must be unsaturated (contain double bonds) to allow copolymerization. Through the connecting of these double bonds with those of the monomer, the polyester liquid is cured. Once catalyzed, a chain reaction takes place giving off heat which speeds the cure even more.

Polyester resins range from very flexible to rigid, depending upon the degree of unsaturation. Often a flexible resin is blended with a rigid resin to obtain a particular resiliency. A single resin can be manufactured readily to duplicate the resiliency of any flexible-rigid combination.

General purpose polyesters, such as just discussed, are used for automobile, truck, and trailer parts, from large body sections to small trim parts. Cost is about 40¢ per lb.

For special applications special polyesters have been developed. By modifying the base resin, polyesters can be made to withstand temperatures between 400 and 600 F without distortion. They can be



Plastics

made to resist fire and chemical attack by adding special chemicals to the base resin.

If a chemical compound that absorbs ultraviolet light is added, the resin can be made to resist discoloration from sunlight.

Curing by catalysts and promoters

The polyester resin is cured by two basic methods.

For a high-temperature cure a catalyst such as benzoyl peroxide is usually used during the matched metal die molding procedure. Temperatures are in the range of 230 to 300 F. Curing takes from 45 sec to 3 min.

For a low-temperature cure the catalyst is also a peroxide, but it is "triggered" by a promoter such as cobalt naphthenate to become effective at room, or slightly higher, temperatures. Curing for this method takes from 1 to 24 hr.

Adding a filler such as clay and calcium carbonate will improve the surface finish, reduce shrinkage, and lower costs.

Since polyesters tend to shrink from 4 to 8% during curing, they tend to crack in resin-rich areas and produce a slightly raised fiber pattern on some surfaces. Inert fillers—about 15% in laminates and up to 50% in premix—reduce the shrinkage and give smoother surfaces. Fillers cost between 1 and 4¢ per lb.

Since resins are clear, desired color can be obtained by adding pigment or dye. Polyester surfaces can be painted, too.

Besides a catalyst, promoter, filler, and pigment, another material must be added to the polyester resin to give it strength. This is usually glass.

Fibrous-glass reinforcement gives strength

There are many types of fibrous-glass reinforcements available. But the basic fiber is the same. It is formed from "E" glass, a lime-alumina-borosilicate glass that is relatively free of soda. Individual fiber filaments are from 0.002 to 0.001 in. thick.

Fibers are stronger than bulk glass but have less chemical resistance. The tensile strength of fibrous glass is about 400,000 psi, independent of filament diameter. Modulus of elasticity is similar to bulk glass: 10,500,000 psi. Modulus of resilience (ability to absorb energy) is about a thousand times greater than bulk glass.

There are three basically different processes for manufacturing glass fibers:

1. Steam or air blowing
2. Flame blowing
3. Mechanical pulling

Most fibers used for the reinforcement of plastics are made by mechanical pulling. The two blown-fiber methods are used primarily for manufacturing fibers for air filters, insulating materials, and staple yarns. All three processes use a small electric furnace with metering orifices in the bottom through which molten glass flows.

When a jet of air, steam, or hot gas is directed

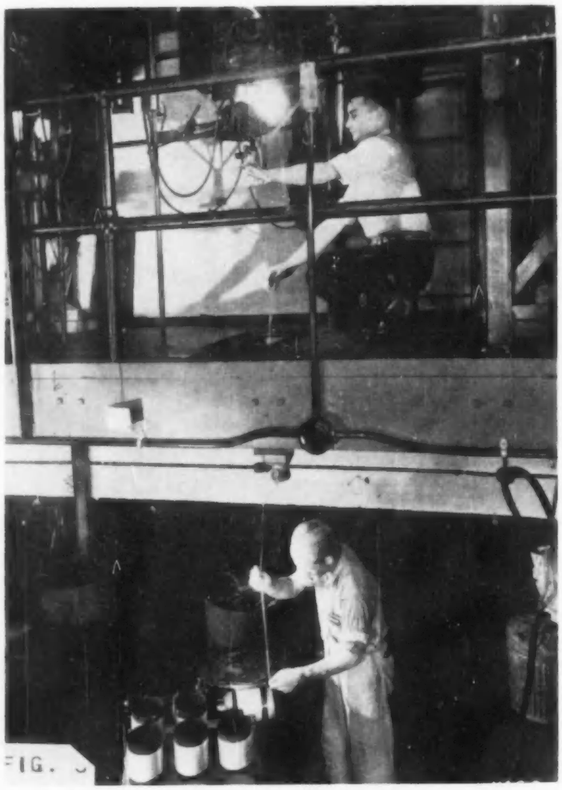


Fig. 1—Mechanical-pulling method of making fibrous glass draws a filament from the stream of molten glass.

at the molten stream, short staple fibers are attenuated and become cool.

The mechanical pulling method, illustrated in Fig. 1 produces a continuous fiber by mechanically drawing a filament from the stream of molten glass at high speed (5,000 to 10,000 fpm). Depending upon the pulling speed, the orifice size, the glass temperature, and other variables, the filaments have a diameter of 0.0002 to 0.00075 in.

Glass filaments are very susceptible to abrasion from one another. Therefore, a lubricant must be applied immediately after forming. Also the filaments must be bonded together in a bundle or "strand" to facilitate handling without becoming fuzzy. Since resins do not adhere to glass readily a primer or coupling agent must be applied.

This coupling agent is known as a "finish." Both silanes and chromes are used, depending upon the strength desired and cost.

Many reinforcements available

There are many types of fibrous-glass reinforcements available. Each material offers its particular combination of handling characteristics, strength, and costs. Figs. 2–9 illustrate these types. Table 1 is a summary of their relative characteristics.

Generally the glass material which gives the highest strength to a plastic is the most costly. On a cost per pound basis, woven fabrics, yarns, and surfacing overlay mats are the most expensive. Reinforcing mats are less. Rovings and chopped strands are the lowest.

The type of resin and the type of reinforcement are only two sides of the FGRP story. The third

Symposium on Plastics

This article is based on the following papers presented as a symposium, ***Fiber Glass Reinforced Plastic—An Automobile Body Material,*** at the SAE Golden Anniversary Summer Meeting, Atlantic City, June 15, 1955:

Polyester Resin

H. A. HOPPENS, Barrett Division, Allied Chemical and Dye Corp.

Glass Fiber Reinforcement

C. E. HOOVER, Owens-Corning Fiberglas Corp.

Matched Metal Die Molding Process Using Preforms

R. S. MORRISON, President, Molded Fiber Glass Body Co.

Design Factors to Be Considered

W. G. SCHULTZ, Ford Motor Co.

Matched Metal Die Molding Process Using Premixed Compound

J. W. GREIG, Woodall Industries, Inc.

Physical Properties of Molded Parts

J. G. COFFIN, Chevrolet Motor Division, General Motors Corp.

Car Heater Bodies and Ducts

A. J. CARTER, Chrysler Corp.

Major Body Panels

C. C. JAKUST, Chevrolet Motor Division, General Motors Corp.

Complete copies of the symposium, containing all papers, are available from Special Publications Department. Price: $1.00 to members, $2.75 to nonmembers.

Fig. 2—Chopped strands of glass fiber are used in the preform process and in premix molding components. Cost is low.

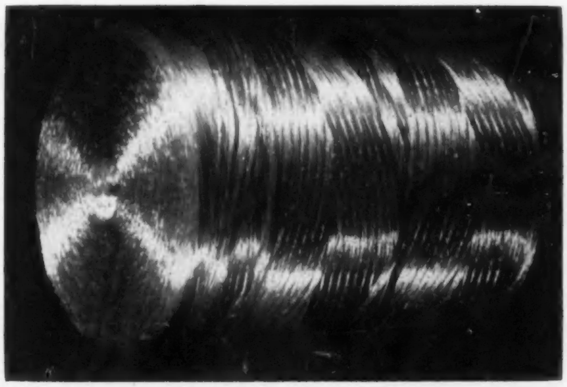


Fig. 3—Rovings are made from a number of continuous strands wound on a tube. They are used primarily in the preform process as well as for local unidirectional reinforcement. Cost is low.

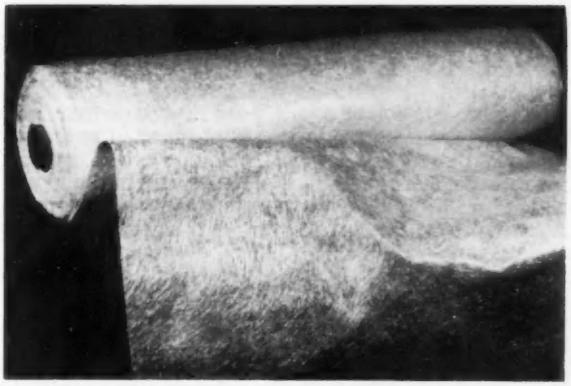


Fig. 4—Non-woven reinforcing mats are made of either chopped strands or swirled continuous strands that are layed down at random. They are held together either mechanically by stitching or "needling" or by adhesive resinous binders.

Fig. 5—Milled fibers are made of strands of filamented glass hammer-milled into small modules. They are used primarily for anti-crazing filler to give greater body and dimensional stability.

Table 1—Comparison of reinforcements

Type	General Description	Reinforcing Characteristics		Applications		Relative Materials Cost
		Normal Glass Content	Directionality	General Use	Typical Application	
Chopped Strands	Bulk cut Strands	35-45%	Multidirectional	Molding Cmpd.	Electrical components	Low
Rovings	Rope-like bundle of continuous strands	50-70%	As desired	Preforming; Unidirectional reinforcement	Machine housings; rod stock	Low
Reinforcing Mats	Chopped or continuous strands in non-woven random matting	20-45%	Multidirectional	Parts with simple contours	Translucent sheet; truck body panels	Medium
Milled Fibers	Bulk, small filamentized modules	2-10%	Multidirectional	Adhesives and castings	Secondary bonding	Low
Yarns	Twisted yarns with after-finish	60-80%	Unidirectional	Unidirectional reinforcement	Fishing rods	High
Surfacing and Overlay Mats	Non-reinforcing monofilaments in random matting.	5-15%	Multidirectional	To improve surface smoothness	Automobile bodies	High
Woven Fabrics	Woven cloths with after-finish available in many styles	45-65%	Unidirectional or bidirectional	High performance parts	Radomes	High
Woven Rovings	Coarse, heavy fabrics	50-70%	Unidirectional or bidirectional	High performance parts	Large Containers	Medium

side—equally important—is the process used to form FGRP parts.

Matched die molding using fibrous glass preforms or mats

Although the hand lay-up and vacuum bag processes have been used to make reinforced plastic automobile parts, the matched die method is more economical and satisfactory for large volume production. This method gives better surfaces, higher strength, and closer thickness control. Fig. 10 is a photo of a reinforced plastic dash panel that was made with matched metal dies.

Fig. 11 shows a cross section of a simple set of matched metal dies. They are made of either steel or alloy iron. Deep dies have their own steam-heating system. Shallow dies pick up their heat from heating plates which are cored for steam.

The dies telescope into each other with a clearance of no more than 0.002 in. A pinch-off cuts the glass fiber reinforcing material—shown here as a preform—to the desired size. It also seals the resin in the dies, forcing it into all areas of the mold.

The fibrous glass preform is made by spraying chopped glass fiber strands on a rotating preform screen. (The screen is the exact size and contour of the male metal die.) A polyester emulsion is also sprayed on the fibers, as they are built up, to hold them on the screen. After the build-up, the door of the preform machine is closed and heat turned on. This dries and cures the emulsion binder. Then the preform is stripped from the screen and laid on the male die. Polyester resin is poured on and carefully spread around. The entire preform is covered with a fibrous glass overlay mat. The press is closed and the material is cured at temperatures between 200 and 240 F for a few minutes. The press opens automatically and the part is removed by the press operators. The edges are sanded and minor imperfections patched by using a pigmented patching material in which short glass fibers have been mixed.

Fibrous-glass mats can be used to make parts where preforms are not necessary. Two layers of fibrous-glass mat, cut to the exact desired pattern, are layed on a table and a measured amount of resin is added. After this resin is spread, another layer of mat and a layer of very thin overlay mat are added. The entire sandwich is then placed in the mold.

Whenever contours are difficult and maximum strength is needed, preforms must be used. This is because the glass fibers can't stretch, and a properly bonded mat will not cover a compound contour without wrinkling or over-lapping.

Matched metal die molding with premixed compound

It has been found that if the same ratio of glass, resin, and filler that is used in the preform molding process is premixed, the resulting soft, dough-like

Fig. 6—Yarns of fibrous glass are made on standard textile equipment. Rovings have largely supplanted yarns as a direct reinforcement for plastics because rovings cost less.

Fig. 7—Surfacing and overlay mats 0.010 to 0.030 in. thick are used over reinforcement to give a smooth surface. These mats offer practically no reinforcing but stabilize surface resin and allow a heavy resin layer to be used.

Fig. 8—Woven fabrics cost more than mats but they give high strength to moldings. They can vary in weight, thickness, style of weave, coarseness of yarns, and glass fiber diameter.

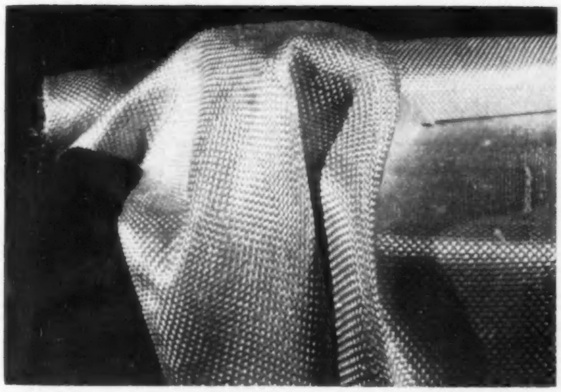


Fig. 9—Woven rovings are made by weaving rovings into coarse, heavy, drapeable fabrics. They cost less than conventional fabrics.

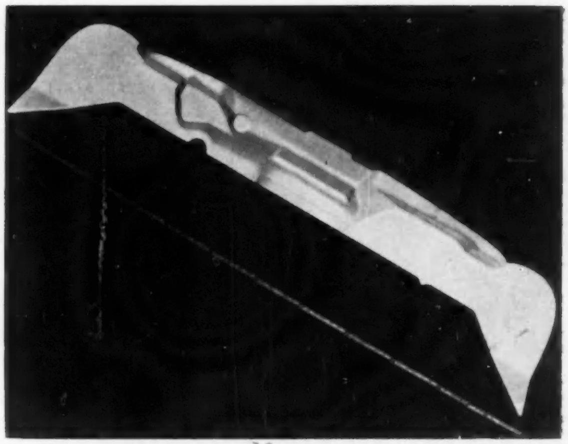


Fig. 10—Dash panel of reinforced plastic was made by the matched metal die process.

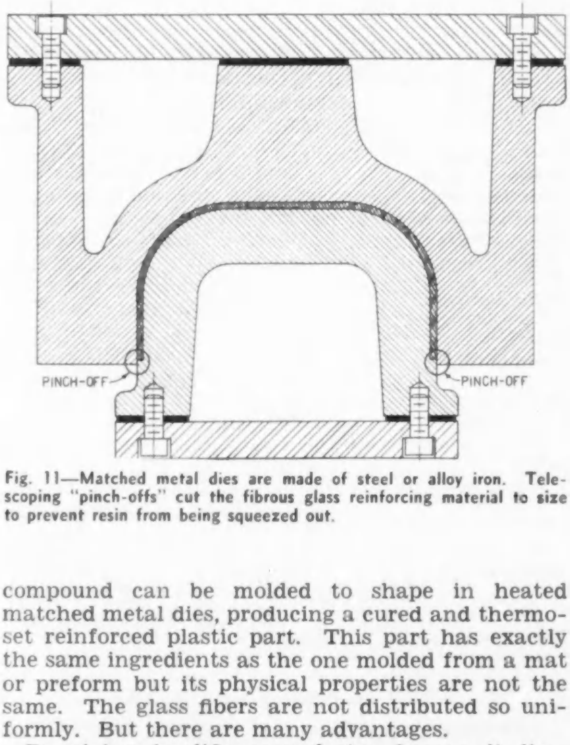


Fig. 11—Matched metal dies are made of steel or alloy iron. Telescoping "pinch-offs" cut the fibrous glass reinforcing material to size to prevent resin from being squeezed out.

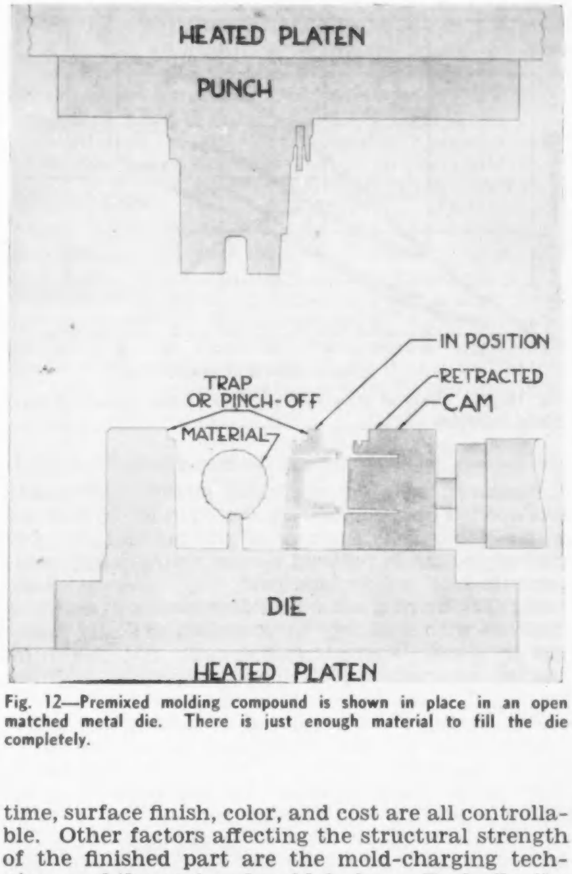


Fig. 12—Premixed molding compound is shown in place in an open matched metal die. There is just enough material to fill the die completely.

compound can be molded to shape in heated matched metal dies, producing a cured and thermoset reinforced plastic part. This part has exactly the same ingredients as the one molded from a mat or preform but its physical properties are not the same. The glass fibers are not distributed so uniformly. But there are many advantages.

Premixing simplifies manufacture because it eliminates the expense of making preforms or die-cut mat blanks. It allows a greater variety of fibers and fillers to be used in their simplest form. It reduces waste material. Production is increased because the relatively low pressure dies can be fed simply and the part can be removed easily. It's possible to mold many details such as holes, slots, grooves, varying wall thicknesses, and bosses into the part. All this reduces cost.

The proportion of each ingredient in the premixture affects the physical properties of the finished part. It may be designed for specific purposes, such as low moisture absorption, high heat resistance, particular electrical properties, and high strength. Its moldability, flow characteristics, cure time, surface finish, color, and cost are all controllable. Other factors affecting the structural strength of the finished part are the mold-charging technique and the part and mold designs. Basically, the part should be designed so that the flow of the plastic material in the mold is not interfered with. An interference will separate the material front as it flows through the die, causing welds to form when the two fronts meet again and flow together. These weld lines are weaker than the rest of the part because some of the fibers line up parallel to the line instead of cutting across it.

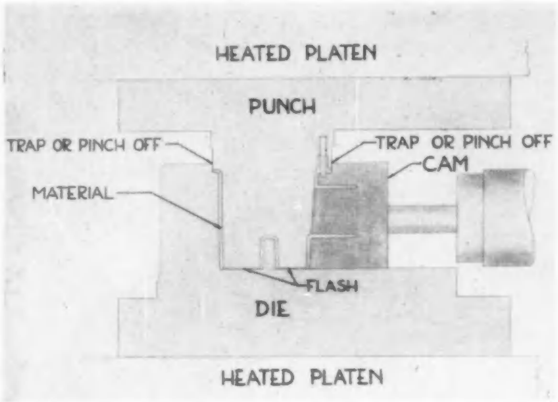


Fig. 13—Die is closed with pinch-offs overlapping to hold the material in the mold. The cam is shown in the open position.

Table 2—Typical mechanical properties of reinforced plastic and steel

PROPERTY	REINFORCED PLASTIC	STEEL (SAE 1010)
Tensile Strength	17,000 psi	45,000 psi
Yield Strength	17,000 psi	35,000 psi
Flexural Strength	25,000 psi	—
Flexural Modulus		
at Room Temperature	1,300,000 psi	30,000,000 psi
at 180 F	600,000 psi	30,000,000 psi
Impact Cracking Resistance		
at Room Temperature	10 in.	6 in.
at -10 F	6 in.	6 in.
at Room Temperature after aging 7 days at 212 F	8 in.	—
Impact Strength		
Notched Izod.	15-20 ft-lb/in.	—
Hardness	Rockwell M-100	Rockwell B-80
Wet Strength Retention (% of original strength retained after 2 hr in boiling water.)	70%	—

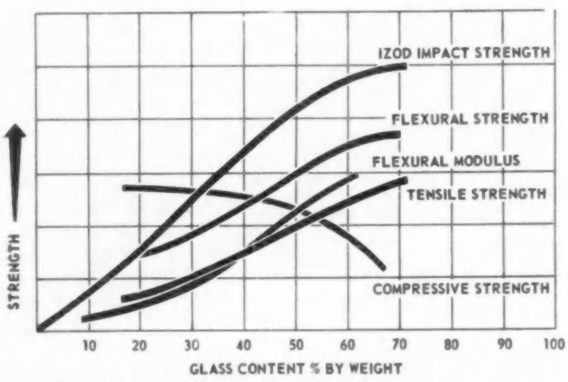


Fig. 14—The effect of glass content on properties of mat-reinforced plastic laminates.

Table 3—Typical physical properties of reinforced plastic, steel, and aluminum

	REINFORCED PLASTIC	STEEL	ALUMINUM
Specific Gravity	1.50	7.87	2.71
Thermal Expansion Coefficient per F	12×10^{-6}	6×10^{-6}	12×10^{-6}
Thermal Conductivity Btu/hr/sq ft/F/in.	2	310	1400
Specific Heat Btu/lb/F	0.3	0.1	0.2
Water Absorption (% weight increase after 24 hr)	0.5	—	—
Corrosion (5% salt spray)	Not affected	Rusts	Corrodes
Flammability	Burns Slowly	—	—

Premixed, reinforced plastic molding compound has opened up a completely new field in product design. Not only is the cost of the product less, but cost of tooling is reduced by combining many components into one molded part.

Fig. 12 shows a male and female die in an open position with a charge of premixed molding material in place. There is just enough material to fill the die completely. The cam of this die is shown retracted so the part can be removed.

Fig. 13 shows the die closed with the pinch-off or trap edges of the die overlapping to hold the material in the die. The cam is shown in the closed position. Note that the pressure of the press is on the material and is only enough to flow the material completely into the mold. The die is held in this position until the part is cured, as in standard compression-molding techniques. The amount of pressure depends upon the material and the distance the material must flow.

Heat for the die is supplied by various conventional methods with temperatures varying between 275 and 350 F and curing time between 30 sec and 2 min. Thicker parts require longer curing time. It is important in designing to avoid one thick section in an otherwise uniform part since it may increase the time cycle and push costs up.

After the part is cured it is removed from the die and allowed to cool. Sometimes a cooling fixture is needed to control shrinking and prevent distortion.

Then the flash is removed from the molding and the part is ready for assembly.

FGRP is strong but brittle

The mechanical properties of FGRP, with the exception of compressive strength, increase in direct proportion to glass content, as shown in Fig. 14. The bundles of glass filaments act as a void space, and reduce compressive strength from that of cured resin alone. Stress applied in other directions, however, is borne mainly by the glass. The resin merely acts as a binder which cements the fibers together. Tables 2 and 3 compare the physical and mechanical properties of reinforced plastic with steel and aluminum. (The composition of the material which was tested was 40% glass, 15% filler, and 45% resin. Panels were cured by the matched die process.)

Unlike steel, reinforced plastic has no distinct yield point, so we consider tensile strength and yield point the same. This property is evident "in action" by the *fact* that it is almost impossible to dent a

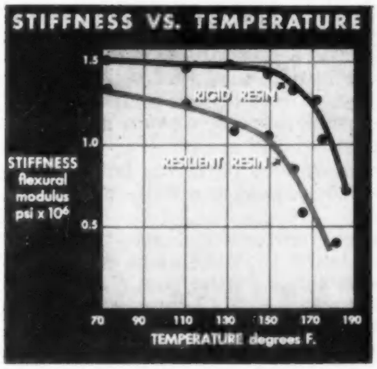


Fig. 15—When a resin is heated, it loses stiffness.

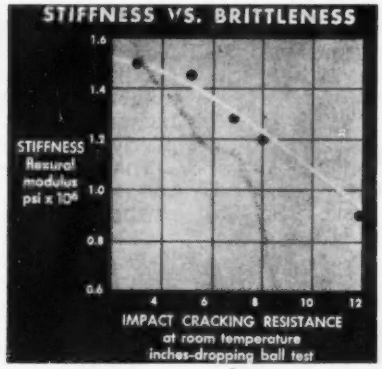


Fig. 16—When a resin is made to resist impact cracking, it loses stiffness.

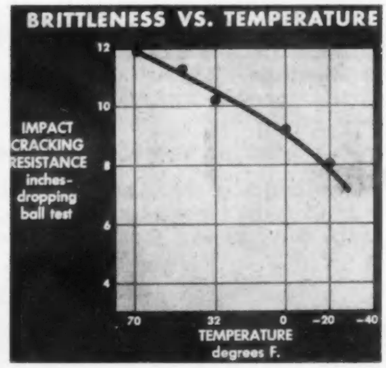


Fig. 17—When a resin is cooled, it becomes more brittle.

plastic fender.

Most of the reinforced plastic used in the automobile industry is about three times as thick as the steel that it replaces. This is because it is not as strong as steel in tension. The increase provides the needed stiffness. Since density of the plastic is so much less, the weight of the three-times-thicker plastic is only slightly over half that of corresponding steel pieces.

Like other organic substances, polyester-fibrous glass materials are influenced by temperature changes as shown in Fig. 15. A laminate having a flexural modulus of 1,600,000 psi at room temperature will test about 800,000 psi at 180 F.

Reinforced plastic made with some flexible resin to give better impact resistance will have a modulus of 1,000,000 psi at room temperature and 500,000 psi at 180 F.

This brings us to the crux of the problem in selecting suitable reinforced plastic for major automotive body panels. We must choose between stiffness and resilience. As shown in Fig. 16 the bending modulus decreases as the resilience or impact cracking resistance is increased. Of course, a compromise is the only solution.

Reinforced plastic becomes more brittle when cooled. Fig. 17 shows that it loses about one third of its room temperature impact resistance at – 20 F.

Reinforced plastic has low thermal conductivity. So, a plastic body panel will feel warmer than one of steel when both are at room temperature. This is because heat is not conducted to or away from one's fingers rapidly by the plastic. The higher specific heat of reinforced plastic (about three times that of steel) means that in designing paint ovens, it is necessary to provide greater heat input for a given work load. It takes three times as long or three times as many Btu's to raise the temperature of a pound of plastic as it does a pound of steel. Since the weight of plastic is only about half, we need about one and a half times as much heat potential in a paint baking oven for plastic.

Reinforced plastic is an excellent electrical insulator. So, when used for an automobile body, grounding must be provided and the ignition must be shielded to prevent radio interference.

Reinforced plastic is resistant to oils, greases, gasoline, anti-freeze solutions, battery acid, salt, and industrial atmosphere contaminants.

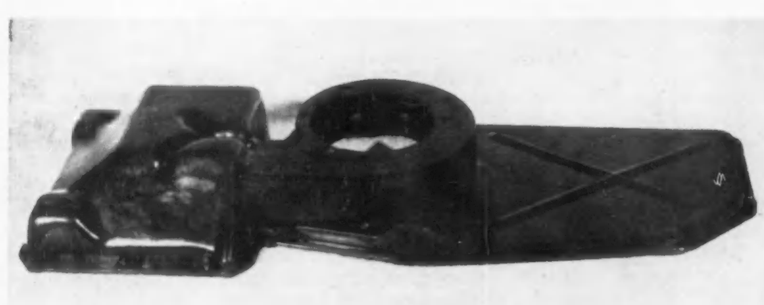
Sometimes, to reduce material costs, sisal fibers are used instead of fibrous glass. However, sisal-fiber reinforced plastics are not as strong or rigid. Some comparative properties are shown in Table 4.

There is little information available showing com-

Table 4—Typical properties of premix molding compositions

	GLASS REINFORCED	SISAL REINFORCED
Tensile Strength	8000 psi	3000 psi
Flexural Strength	12,000 psi	5000 psi
Flexural Modulus		
at Room Temperature	1,500,000 psi	700,000 psi
at 180 F	800,000 psi	400,000 psi
Impact Strength—		
Notched Izod	5.0 ft-lb	3.5 ft-lb
Hardness	90 Rockwell 'M'	80 Rockwell 'M'

Fig. 18—Photo of an engine side housing made of sisal-fiber reinforced plastic.



parative fatigue properties for different reinforced plastic compounds. However, preliminary studies indicate that the endurance limit for some materials is about 20% of the ultimate strength and that cycling speed is important.

Making reinforced plastic parts

One major use of sisal-fiber reinforced material is in Chrysler's heater housing and duct. The sisal keeps the cost low (comparable to steel) and provides sufficient strength for the job. By making the heater housing and duct system out of molded reinforced plastics there is a substantial savings from eliminating labor to handle and spot weld a large number of stampings. There are no sealing, painting, and assembly problems which often arise with poorly fitting parts.

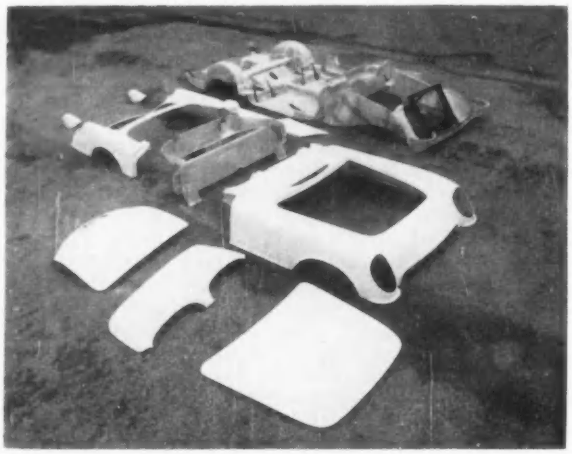


Fig. 19—Sports car body is designed to integrate body panels into as few pieces as possible.

The plastic heater system performs better than the steel system. It looks neat and well-engineered, as shown in Fig. 18.

Chevrolet has used reinforced plastic for major body panels. They found that the piece cost varies with the volume and shape of the part. Generally plastic is cheaper than steel for low volumes. But a flat, or nearly flat, panel may be much cheaper in steel than in plastic—regardless of how many are made—whereas a panel with a complex shape will be cheaper in plastic at a relatively *high* volume.

Chevrolet found that it is best to combine as many pieces as possible into large single molded parts. Fig. 19 shows this practice. Many small pieces have been combined to form large molded parts. In a steel body, these panels are usually made in off-the-line welding fixtures where many small pieces are welded together to form large panels for the final assembly.

One problem is that flanges, which are usually required for line assembly, cannot always be molded in the part. When this happens, extra pieces, requiring extra bonding for attachment, must be included in the design.

Of course, all panels must be planned to permit molding without backdraft or undercuts which are difficult to handle in matched die production.

One example of the use of reinforced plastic is the special pick up truck shown below.

Plastics Permit Special Styling

It was desired to convert this standard pickup truck into a model with special styling. Reinforced plastic panels, which were large and complicated in shape, were added. The left and right fender assembly and tail gate outer panels are shown in white. Dark colored pieces are two front filler panels and the spare tire carrier which is slung under the pickup box.

BEFORE

AFTER

HOW

W. M. Cattrell, Ryan Aeronautical Co.

Based on paper "The Design and Development of High-Temperature Pneumatic Ducting Systems for Aircraft" presented at SAE Golden Anniversary Aeronautic Meeting, Los Angeles, Oct. 14, 1955.

Pneumatic Ducts

. . . have designers up in the air

THE design of pneumatic ducts for the airplane of today presents many complex problems. Among these are:

1. Selection of suitable duct materials
2. Allowance for expansion of ducts and structural deflection of aircraft
3. Methods of insulation for high-temperature units
4. Provision of mechanical duct joints
5. Provision of appropriate bends
6. Special cases of duct bending and forming
7. Provision of duct supports
8. Lack of standardization

Selection of Suitable Duct Materials

The trend in military applications is toward the use of higher strength materials in lighter gages that permit a substantial savings in weight. For example, 19-9DL or 19-9DX due to their higher yield and fatigue strengths may be used in a lighter gage for a particular application than either SAE 30321 or SAE 30347 stainless steel.

Duct Expansion and Structural Deflection

Thermal expansion of ducts and structural deflection of the aircraft are in many instances of appreciable magnitude. Provisions must be made in most ducting systems to allow for them. One method is through the use of loops and omega bends, but these require large spaces only found in the fuselage sections of large aircraft.

Another method is through the use of bellows. Aircraft pneumatic ducting systems have included plain bellows, braid-restrained bellows, and bellows employing internal and external gimbal supports.

The degree of success of these methods has varied with the pressure and temperature conditions, the frequency of flexure, and the speed and quantity of air to be passed through the system.

High-Temperature Insulation

How to insulate high temperature units is still a major problem. Although adequate protection is sometimes provided by shielding, it must generally be accomplished by the use of an insulation assembly.

Insulation assemblies may be a separate or an integral part of each ducting segment. Each type has its advantages and disadvantages. Regardless of type, the assembly used should have high insulation properties and be resistant to damage from ordinary insulation hazards.

In addition, it should be easy to handle and easy to secure in place. Insulation consisting of fibrous glass batting covered with woven glass fabric impregnated with neoprene has been found to be superior in meeting these specifications. This material has little tendency to absorb water—or "wick." So it doesn't grow heavier as water-absorbing insulations do.

Surface coverings for insulation may be either fabric or stainless steel foil, depending upon the demands of a particular application. The metal foil may be texturized to give it added handling strength. Surface covering made of foil also permits the use of pre-formed shapes for complex ducting sections.

If the insulation assembly is separate from the duct, it is generally desirable to face the inner as well as the outer surface of the insulation material with foil to meet non-wicking specifications. The allowable heat loss determines insulation thickness.

Mechanical Duct Joints

Provision must be made for mechanical joints which permit convenient removal of either ducting segments or adjacent airframe parts. Such joints must be highly leak resistant. The clamps or other apparatus used to seal the joints should be light in

weight, reusable, and of such design that either removal or installation can be effected with ease.

Pressure and temperature criteria determine the most suitable type of joint. Ducts subjected to extremely high pressures and temperatures are sometimes joined by forged stainless steel flanges faced with a suitable gasket and secured with bolts.

Ducts subjected to moderate pressures and temperatures are often joined by a V-band removable clamp that employs sheet metal flanges and a relatively soft sealing gasket. Small ducts are usually joined by a threaded-nut and flared-tube coupling.

Provision of Appropriate Bends

Bends of various radii are accomplished by either of two methods—by forming half-stampings that subsequently are welded together, or by bending a tube to the desired radius.

Half-stampings provide an excellent way to achieve a desired configuration, particularly if the duct bend radii are sharp and the quantity of ducts to be produced is small. Extremely sharp bend radii associated with compound bends are easily formed by relatively inexpensive drop-hammer dies.

Often the geometry of a ducting system will determine and sometimes limit the material that can be used. The permissible degree of bend is a function of the ductility of the material to be formed. However, the use of multiple-stage forming operations will frequently permit the selection of a material that could never be considered if the forming were attempted in a single operation.

Although unusually hard materials are more difficult to form, their use is justified because their greater strength permits the use of lighter gages with a resultant saving in weight. This principle is exemplified in the thinning that occurs in duct walls as a result of making bends.

Tests indicate that reduction in wall thickness does not necessarily result in loss of strength because the work hardening in the thinned material tends to compensate for the reduction in thickness.

Special Cases of Bending and Forming

The fabrication of transitions, branch line connections, and Y-sections are special cases of duct bending and forming. Transitions are made by hydraulically forming tubular sections provided the transition is not too severe.

If the transition is exaggerated, with elliptical cross-section and almost flat sides, it may be necessary to consider a heavier gage of materials. An alternative solution is to install welded dividers to minimize possible fatigue failure induced by "breathing" of the flat sides.

The pressure and temperature under which the duct will operate determine the seriousness of this problem. They may be of such magnitude as to preclude the use of any duct shape other than one which is round, or nearly round.

Branch line connections may be made by forming a circular flange in the wall of the main line to which the branch may be either fusion welded or spotwelded for strength and silver brazed for sealing.

Another method is the use of a separate saddle-shaped member which connects the main line and the take-off line. This saddle is attached to the members that it joins in the same manner as if a direct contact were made between the main line and the branch.

Y-sections are formed from half-stampings. Experience shows that in most cases the crotch should be reinforced with a saddle-shaped member usually of heavier gage than the duct material.

The saddle should extend a distance sufficiently far from the crotch to prevent the welded edge of the saddle from being subject to damaging stresses that will result when internal pressure fluctuations are applied to the duct.

Provision of Duct Supports

Each ducting system needs careful analysis in order to determine the magnitude of inherent Bourdon effects. Provision must be made for transferring these end load effects into the structure of the airplane.

In some cases, it is either virtually impossible or impractical to provide proper expansion devices to eliminate end loads on the ducts. The Bourdon effect is of such magnitude that rigid external supports must be employed to absorb part of the end loads. If the duct were unrestrained, the snaking and squirming action induced by changes of internal pressure would produce premature failure at critically over-stressed points.

Lack of Standardization

Standardization of duct sizes and qualification tests would be of considerable aid to industry. At present, for instance, fabricators prefer to standardize as few duct sizes as possible. This enables them to operate on a minimum tooling investment. On the other hand, designers would prefer a fairly large selection of sizes to meet their requirements with more precision. In the interests of economy, a meeting ground for these two viewpoints should be clearly defined.

Standardization of qualification tests would allow most components and assemblies to be readily tested. This would assure safe operational characteristics.

Preparation of these specifications should give consideration to the following test criteria:

- Proof pressure
- Burst pressure
- Methods of applying pressure
- Cyclic pressure requirements
- Procedures for determining surface temperatures and conductance values
- Procedures for determining the heat-transfer properties and the wicking characteristics of insulation materials.

In summary, it should be emphasized that the design of aircraft ducting systems should be undertaken with a keen awareness of all the complex design problems involved. If proper consideration is not given to each of the important design considerations, the system will have shortcomings which may be time-consuming and costly to correct.

(Paper is available in full in multilith form from Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

John Deere designs for low operating costs . . .

The Model 70 Tractor Diesel Engine

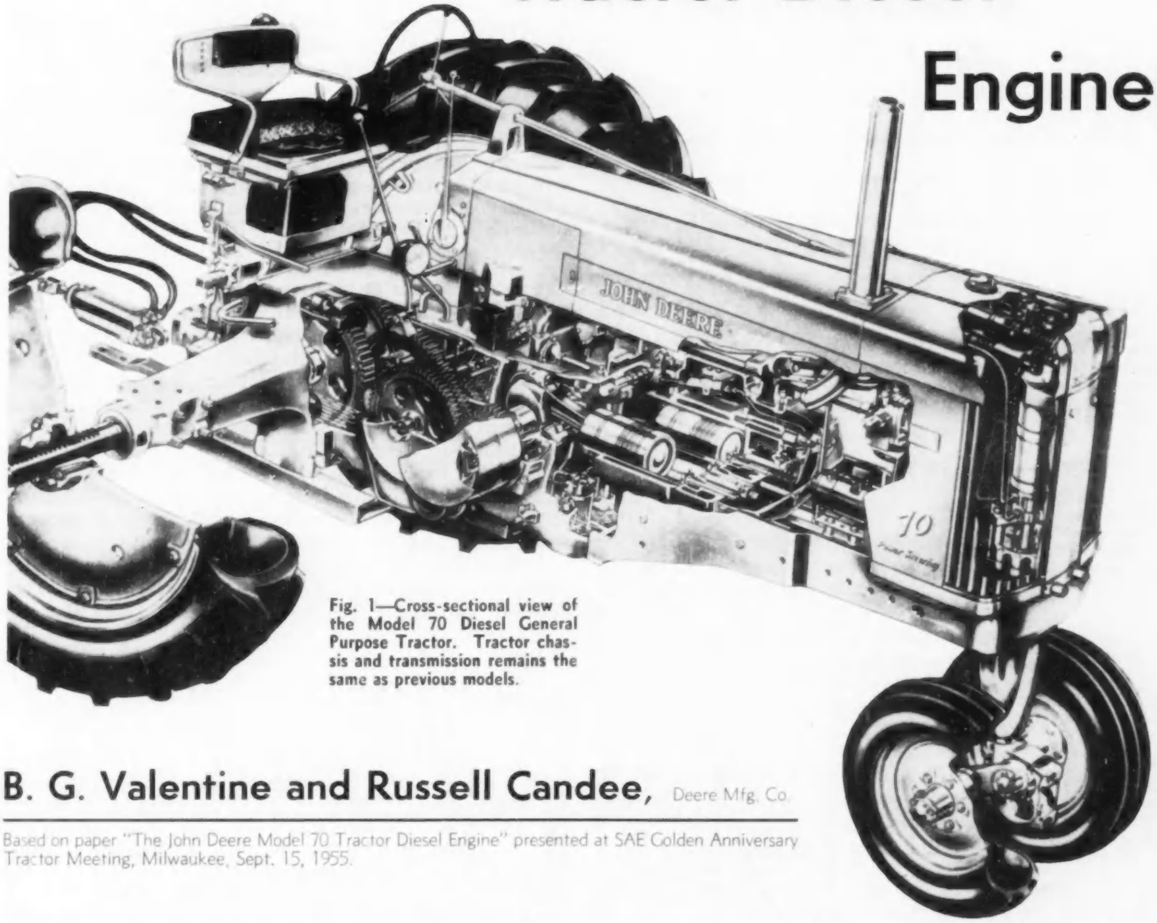


Fig. 1—Cross-sectional view of the Model 70 Diesel General Purpose Tractor. Tractor chassis and transmission remains the same as previous models.

B. G. Valentine and Russell Candee, Deere Mfg. Co.

Based on paper "The John Deere Model 70 Tractor Diesel Engine" presented at SAE Golden Anniversary Tractor Meeting, Milwaukee, Sept. 15, 1955.

THE new John Deere Model 70 diesel engine features:

1. Adaptability to the present tractor chassis and transmission
2. 15% less fuel consumption
3. Excellent diesel engine design
4. Gasoline engine starter
5. Design for optimum engine performance

Adaptability and Fuel Economy

Design of the new diesel retains the chassis and transmission of the John Deere 70 series of farm tractors. Adaptation of the engine and its starting system is accomplished within the confines of the chassis and hood with no detrimental increase in external bulk or change in wheelbase. The tractor (Fig. 1) is practically identical in appearance to the Model 70 gasoline machine, differing only in detail.

Although rated engine speeds are different for the gasoline and diesel tractors, ground speeds and power take-off speeds are maintained the same. This is accomplished by changes in the ratio of the first stage of gearing connecting the engine to the transmission, rather than changes in the transmission itself. Fig. 1 shows the power train from the engine through the transmission and to the power-shaft.

Low fuel consumption and relative insensitivity to fuels result in low operating costs for the new diesel. Specific fuel consumption is approximately 15% less than that of the average diesel tractor. In drawbar work the tractor develops 15.78 hp-hr per gal as compared to 13.30 hp-hr per gal of fuel for the average of other diesel farm tractors.

Except for cold starting, the engine is relatively

insensitive to fuels. Fuels with cetane numbers ranging from 40 to 60 can be used with no change in timing required. Either ASTM No. 1-D or No. 2-D fuel is satisfactory—with the latter generally recommended due to its higher heat content per gallon.

The crankcase oil recommended for general use is API Service Classification DG. If the fuel has more than 0.5% sulfur, crankcase oil meeting the requirements of Service Classification DS is recommended to reduce carbon fouling of the piston rings.

Diesel Engine Design

Pertinent features of the Model 70 diesel engine are:

Basic Design: The engine is of the two-cylinder horizontal direct-injection type with crankshaft mounted crosswise with respect to the tractor. Additional specifications are shown by Table 1. Starting of the diesel is accomplished by means of a small gasoline engine.

Crankshaft: The crankshaft design includes a center main bearing for rigidity with economical use of crankshaft material. The three-main-bearing crankshaft has 4½-in. diameter journals, and 3-¾-in. diameter crankpins. It weighs 120 lb. The journals overlap the crankpins 15/16 in., which adds greatly to the stiffness of the shaft.

Lubricating oil is fed to the outside main bearings. Drilled holes in the crankshaft supply oil to the crankpins and center main bearing. Holes drilled into crankpins reduce rotating weight. The oil holes are on the neutral axis of the pins and the journals and do not intersect the lightening holes. This construction makes closures for the drilled crankpins unnecessary.

Fuel Injection Equipment: All fuel injection parts are fully protected from dust and disablement from external sources. The fuel injection pump cams are included on the valve camshaft. By machining to close limits and by using precision assembly fixtures for the camshaft drive gears, no adjustment of the camshaft is required at assembly for either injection pump or valve timing.

Injector fuel leak-off is piped directly to the inlet port branches. John Deere finds this a satisfactory method of disposing of leakage. Leakage of coolant is prevented by an "O" ring seal.

Design of inlet valve centers ½ in. below cylinder centers permits greater opening of the inlet valves and allows desired port configuration. Inlet and ex-

Table 1—Specifications of Model 70 Diesel General Purpose Tractor

Engine	Two-Cylinder, Horizontal, Four-Stroke Cycle
Speed	1125 rpm
Bore and Stroke	6-⅛ x 6-⅜ in.
Compression Ratio	16 to 1
Observed Belt Power (Nebraska Test 528)	50.40 hp
Brake Mean Effective Pressure at 50.40 Belt hp	94.5 psi
Power Take-Off (Optional)	direct engine or transmission driven
Hydraulic System (Optional)	Power-Trol with engine-driven pump
Tire Size: Front	600 x 16
Rear	12-38 or 13-38
Transmission	Six-speed spur gear
Steering	manual or power
Fuel Tank Capacity	20 gal
Wheel Base	91 in.
Rear Wheel Tread	60-88 in.
Shipping Weight	6520 lb
Dimensions: Width	86-⅝ in.
Length	136-¼ in.
Height	88-1/16 in.

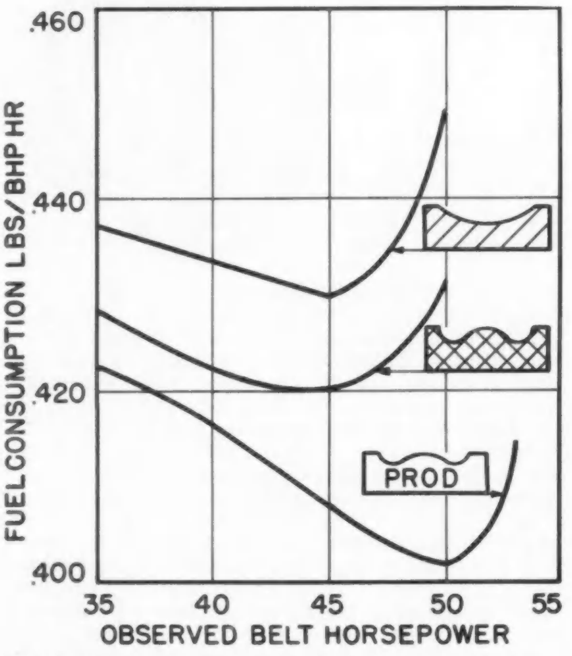


Fig. 2—Effect of combustion chamber design on engine performance at 1125 rpm. Note that two of the combustion chambers are quite similar, yet there is a marked difference in engine performance.

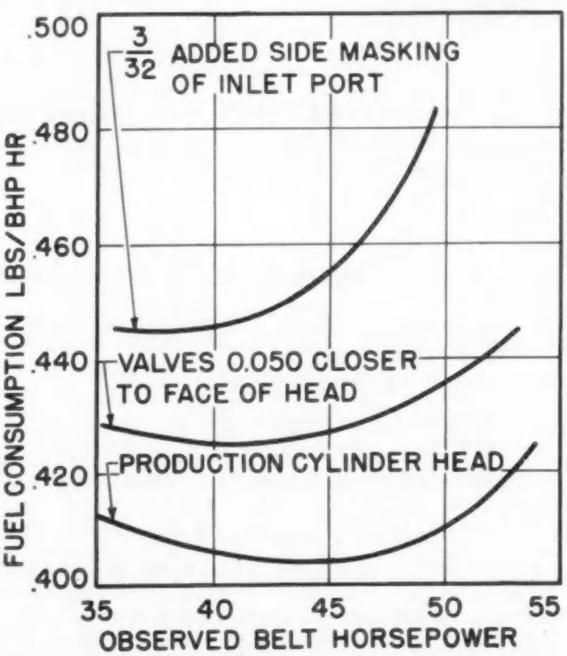


Fig. 3—Effect of cylinder head changes on engine performance at 1125 rpm. Note the lower fuel consumption of the production cylinder head.

haust valve seats are set back from the face of the cylinder head, making clearance reliefs unnecessary. Such an arrangement gives desirable swirl characteristics to the inlet air.

Gasoline Engine Starting

The use of a gasoline engine for starting the diesel eliminates the excessive battery capacity and required starting aids of direct electric starting. As a relay between the electric starter and the diesel engine it has the following advantages:

1. It provides minimum size and cost of the electric starting equipment including the battery.
2. The gasoline engine costs less than direct electric cranking for comparable cranking ability.
3. The starting engine heats and circulates coolant through the diesel engine cylinder jacket to condition the cylinder bores for starting.
4. The starting engine exhaust is passed through a heat exchanger raising the temperature of the air entering the diesel cylinders.
5. The diesel engine can be cranked for an indefinite period. This feature is significant not only in starting but also for field check of injection pump calibration and nozzle condition.

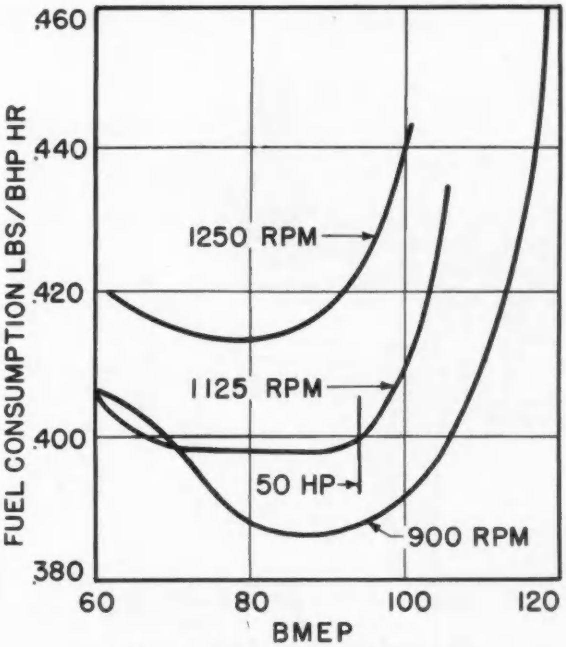


Fig. 5—Engine performance at various speeds.

Engine Performance

Numerous combustion chamber shapes were tested in developing the Model 70 diesel engine. Fig. 2 shows some engine performance results with three designs of open type combustion chambers. It will be noted that two of the combustion chambers were quite similar, yet there was marked difference in engine performance.

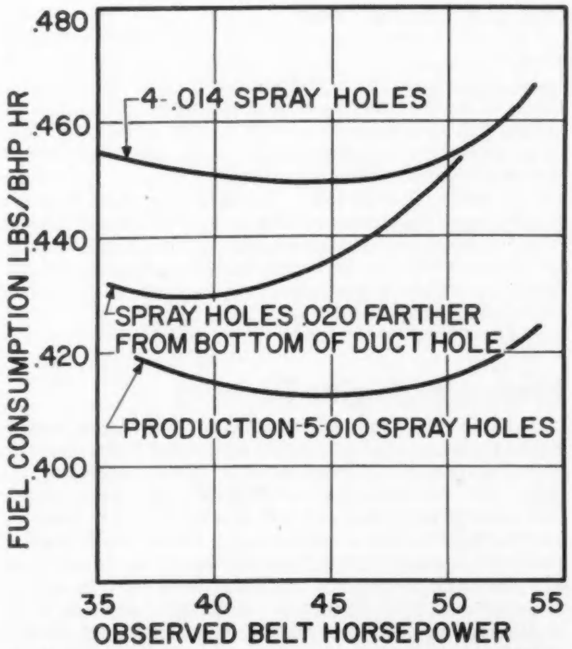


Fig. 4—Effect of nozzle tip design on engine performance at 1125 rpm. Again, lower fuel consumption results with the production nozzle.

The configuration of intake ports in the cylinder head, the positioning of valves with respect to the face of the head, and even the size and shape of the counterbore around the valves are all significant factors in engine performance. The desired swirl rate was secured by use of the directed port, but close attention to detailed construction was required by further engine test to take best advantage of the port characteristics. Fig. 3 shows engine performance response to some of these changes.

The nozzle tip is of the spray type having five 0.010-in.-diameter holes at an included angle of 160 deg. Fuel velocity is 330 m per sec. This speed presents maximum protection against carbon fouling of the spray tips. Fig. 4 illustrates some engine performance comparisons with various spray tips.

As would be expected, the change in number and size of spray holes affected engine performance. The location of the spray holes with respect to the bottom of the center or duct hole is also important. On the production tip the spray holes are located radially on the same center as the radius of the bottom of the duct hole. Moving the spray holes 0.020 farther from the bottom of the duct hole resulted in the reduced performance as shown by Fig. 4.

Engine performance characteristics at various speeds are shown by Fig. 5. The engine governor has an override feature that gives additional opening of the fuel pumps as the engine is lugged under rated speed for greater torque reserve.

For complete paper (in multilith form) on which this abridgment is based, write SAE Special Publications. Price: 35¢ to members, 60¢ to nonmembers.

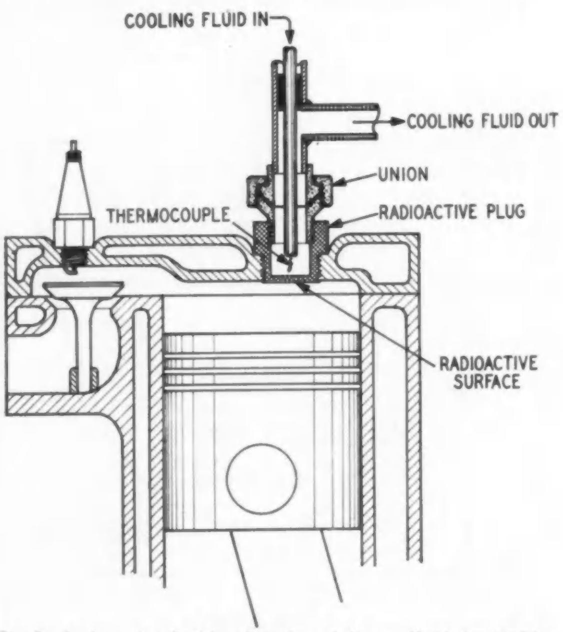


Fig. 1—A plug painted with radioactive cobalt or sulfur is inserted in a cylinder. (Circulating fluid keeps temperature constant.) As deposits are formed on the end of the plug, radiation is attenuated. This gives a measure (by geiger counter) of deposit thickness.

Automotive research laboratories are finding

New Uses

USE of radioactive tracers in automotive research is expanding rapidly. It is a sensitive and quick method that permits certain engine wear studies that can't be made by any other known methods. Recently it has been used to measure engine deposits, metal transfer between electrical contacts, the load-carrying ability of lubricating oil, and the effect of dust on piston ring wear.

This relatively new research tool is so accurate that a teaspoonful of radioactive salt dissolved in Lake Erie could be detected and measured. Engine deposits as thin as ten millionths of an inch, can be measured, and deposition rate can be indicated after only a few hours compared to tens or hundreds of hours by conventional methods.

Basically, the method consists of activating an engine part in a nuclear reactor, then assembling it into the engine. As the engine is operated, any particles worn off the part can be detected by a scintillometer. This technique is varied slightly to get different types of data.

Measuring Engine Deposits

To measure engine deposits, a removable plug is coated with radioactive material and inserted into the combustion chamber of an engine. (See Fig. 1.) The rate of radiation is determined by a geiger counter. Then the engine is started and run for several hours. As deposits build up in the chamber and coat the end of the plug, radiation is attenuated. The amount of deposit is determined by comparing the reduction in radiation with the reduction in radiation caused by absorbent material of known thickness.

Sulfur-35 and cobalt-60 have been found to be the

This article was based on papers sponsored by SAE at the **Nuclear Engineering and Science Congress**, Cleveland, December 12, 1955. Representing SAE as presiding officer at the session was **A. L. Pomeroy**, Thompson Products, Inc. Papers, which are listed below, are available in full from the American Institute of Chemical Engineers, 25 West 45th Street, New York 36, N. Y. Price: 30¢ per copy.

Radioactivity As A Sensitive Tool For Measuring Engine Deposits

J. G. Mingle, H. W. Sigworth, and B. A. Fries, California Research Corp.

Electrical Contact Studies with Radioactive Tracers

C. R. Lewis, Chrysler Corp.

Application of Radioactive Tracers to Engine Research

A. Hundere, G. C. Lawrason, and J. P. O'Meara, Southwest Research Institute

For Radioactive Tracers

most suitable radioisotopes. They have the following advantageous properties:

(1) Their half-lives are long enough so that the plugs can be used repeatedly over an extended period.

(2) There is sufficient radiation for accurate measurements of the extremely thin deposit thicknesses encountered.

(3) They are easy to apply on the surface of the plug and they resist chemical or physical deterioration.

Sulfur-35 is applied to plugs (made of mild steel) by dipping them in elemental sulfur dissolved in hot mineral oil, or by painting the end surface of the plug with a thin film of dilute ammonium sulfide (containing high specific activity sulfur-35). A protective coating of nickel is electroplated over the radioactive surface to prevent surface deterioration and to permit the plug to be used again.

Cobalt-60 surfaces are applied by electroplating labeled cobalt sulfate.

Radioactivity of the plug is measured by a thin end, mica window, geiger tube, such as Amperex 200 CB, and a scaler. The plug's radiation is counted prior to use, then again after the deposit has formed.

To determine the relationship between radiation attenuation and deposit thickness, several polystyrene and cellophane foils of known thickness are placed between the plug and the counter tube. Then a plot of the logarithm of the count rate for each absorber thickness is made. As shown in Fig. 2, the slope for sulfur-35 is considerably steeper than for cobalt-60. This corresponds to a greater sensitivity. A change of 1% in count rate, which is about the minimum that can be counted accurately, represents a thickness change of 0.05 mg/cm^2 with sulfur-35 and 0.2 mg/cm^2 with cobalt-60. Consequently, sulfur-35 is used to measure light deposits, such as in the engine induction system, and cobalt-60 is used for heavier deposits, such as those in the combustion chamber. With 85-year nickel-63 a 1% change in count rate corresponds to 0.01 mg/cm^2 thickness. The tail at the end of the absorption curve is probably due to cobalt-60 impurity in the nickel-63.

Induction system deposits can be measured similarly by placing radioactive plugs in the throttle plate section of the carburetor, in the heat riser or stove section of the intake manifold, and at the

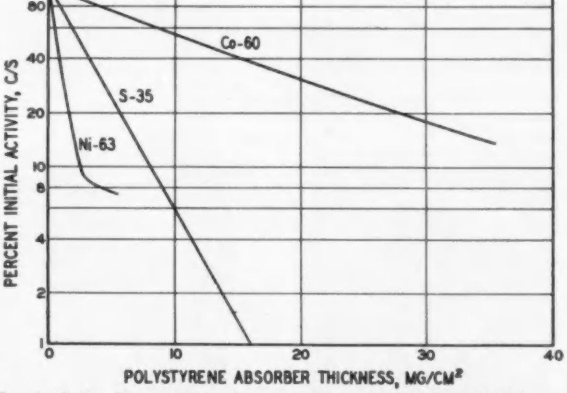


Fig. 2—Sulfur-35 gives a much more sensitive test of deposit thickness (simulated by polystyrene absorbent materials) than cobalt-60. A 1% change in radioactive count rate represents a thickness change of 0.05 mg/cm^2 with sulfur and 0.2 mg/cm^2 with cobalt-60, and 0.01 mg/cm^2 with nickel-63.

three branches of the intake manifold. The influence of blowby on throttle body deposits is shown in Fig. 3.

This radioactive deposition plug test has also been found very useful in exploring how gasoline composition, additives, and engine operating conditions influence deposition. By far the most extensive application of radioactive tracers in engine research is in the study of wear rates.

Measuring Engine Wear

If an engine part such as a piston ring, gear, or bearing is made radioactive by putting it in a nuclear reactor, its rate of wear can be determined by reassembling it into the engine and measuring the amount of radioactive material that is worn off during operation. The particles are usually circulated in an oil system, as shown in Fig. 4. With the rate of oil flow constant, any increase in the radiation count by the geiger tube indicates an increase in the amount of radioactive particles being worn off the part.

The accuracy of the radioactive wear measurement is determined primarily by the counts per minute per milligram of radioactive metal worn from the engine part. For most tests a very long geiger tube immersed in a large volume of oil gives sufficient sensitivity. In certain cases a scintillation counter is more efficient for counting gamma rays and, when coupled with a pulse height analyser, it cuts down background radiation count. Many inches of lead shielding are required to reduce the radiation from the engine itself.

The meter reading in counts per minute is related to weight of iron removed from the ring by dissolving a small, weighed portion of the piston ring in a solvent and counting (by geiger counter) various dilutions of this stock solution to obtain a calibration curve.

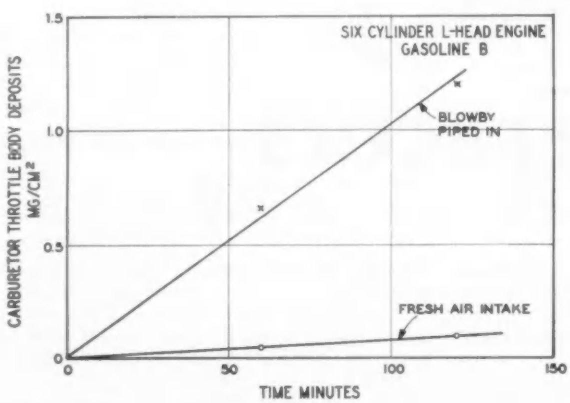


Fig. 3—Throttle body deposits caused by blowby can be measured by the radioactive plug technique. Time required for the test was reduced from about 40 hr using conventional methods to about 3 hr using the radioactive plug.

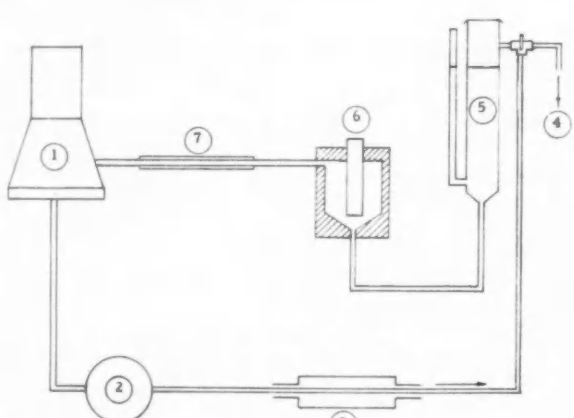


Fig. 4—Schematic diagram of oil system for radioactive ring wear studies. 1—test engine, dry sump; 2—scavenge pump; 3—cooler; 4—dump; 5—sump; 6—lead-shielded geiger tube; 7—heater.

Measuring Oil Characteristics

Tests made of piston ring wear by this method show that heavy duty oils that have effective additives to prevent corrosive wear give low wear rates when the oils are new; but after a while, additive depletion causes the wear rate to increase.

Another use of the radioactive technique, giving information that cannot be obtained by conventional wear measurements, is determining the load-carrying ability of arctic oils. These are light 5-W type oils that have poor or borderline load-carrying ability in many engines. A one-cylinder, two-cycle diesel engine of 71 cu in. displacement was used in a test which provided wear versus time curves. Engine rpm and bmep was increased until the total wear reached a set amount or the limit of the engine was reached. Results, in Fig. 5, show that oil A had practically no load-carrying ability. Oils B, C, and D have essentially the same wear characteristics up to a certain load (different for each oil) where the curve breaks. The knee in the curve is the load at which the lubricant changes from hydrodynamic, or quasi-hydrodynamic, to boundary lubrication.

Measuring Electrical Contact Wear

Since only a very few atoms of radioactive material are needed to give quantitative measurements, the radioactive tracer technique can be used to study the wear of electrical contacts such as those in the pressure switch controlling an automobile stop light.

When a pair of contacts is closed the point of contact gets so hot that the two metals invariably weld together. When the contacts are opened again, the weld breaks leaving one contact with material taken from the other.

Also, an arc may form between the separated contacts which is hot enough to vaporize the metal. In such an arc, metal is withdrawn from one surface

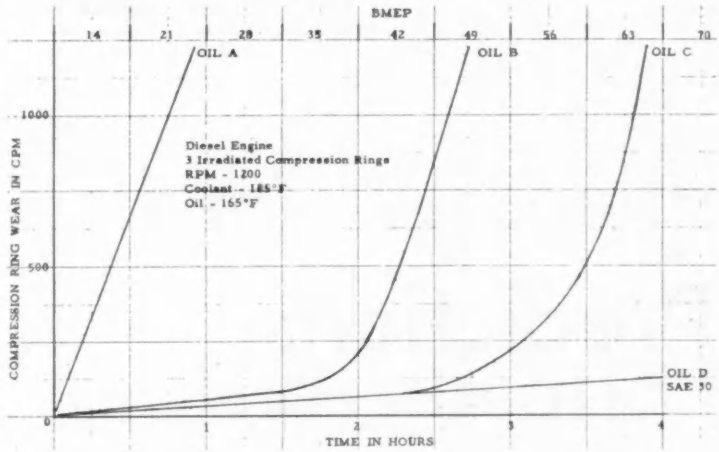


Fig. 5—Wear characteristics of light (arctic) oil. Oil A had practically no load-carrying ability. Oils B, C, and D have essentially the same wear characteristics up to a certain load (different for each oil) where the curve breaks.

and deposited on the other in much the same way electrodeposition in a liquid bath transfers metal.

If the contact from which the metal is taken is made radioactive (by exposing it to a nuclear reactor), the material transferred can be measured accurately within a few micrograms.

The amount of transferred radioactive metal is measured by a geiger counter that counts gamma rays. (An aluminum absorber is placed in front of the geiger tube to prevent any beta particles from entering the detector. This improves accuracy.)

In a test which disconnected and closed the contacts automatically, approximately 10 micrograms of material were transferred in 100 closures. After 100,000 cycles, about half a milligram had been transferred.

Part of the transfer is due to vapor formed at the arc and is always from the positive to the negative contact. If the weld (or bridge) transfer could be made to go in the opposite direction, the net metal transfer would be cut down. This can be done if the two contact metals are different, with the negative contact having higher resistance and lower melting point than the positive contact. Also, neither contact material can form oxides which would interfere with continued operation.

After testing many materials, it was found that silver and cadmium were satisfactory, transferring less than 10 micrograms after 250,000 closures. (See Fig. 6)

The same information could undoubtedly have been obtained by other methods; but the speed, convenience, and accuracy of the radioactive isotope method speaks well for its usefulness in automotive research.

Radioactive Method is Safe

The use of radioactive tracers in the engine laboratory has been found quite safe. The activities of irradiated parts are relatively low and the time that any personnel spend close to active material is short. Too many special, long-handled tools may be so awkward to handle that exposure time may become unnecessarily long. So, test procedures should be set up so that operations are performed within a total dosage determined by time divided by the square of the distance from the radiation.

Once laboratory personnel are told that the level of dosage is very small—comparable to radiation received during dental or chest x-ray, radiation from a luminous dial watch, or cosmic-ray background—apprehension usually disappears. For added safety, however, health physics instruments must be used to monitor dosage.

Macroscopic inspections should be done from behind a lead shield using a mirror for observations. For micro-inspections, California Research Corp. has built a 3-ft periscope microscope of 18 power. They also make photo-micrographs, having found that the radiation has no measurable effect on the film for the short time required for taking the photographs.

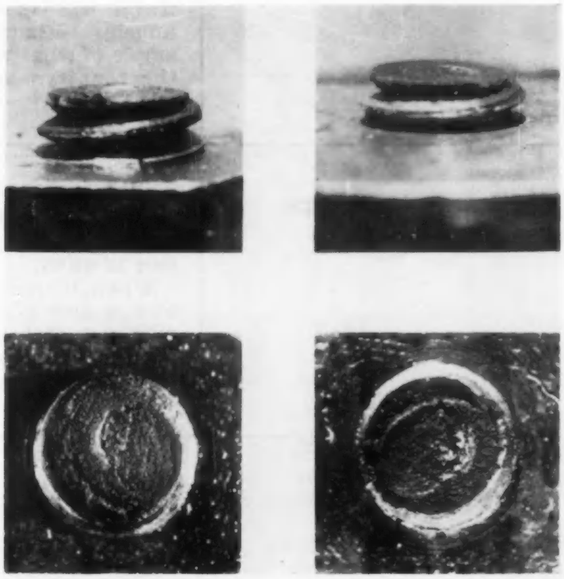


Fig. 6—Less than 10 micrograms of material were transferred after 250,000 test closures with contacts made of silver and cadmium. Photos show that although small scale transfer has taken place, no large mound or crater has been formed.

William S. James, Engineering and Research Consultant

Predictions

on Passenger Car Engines

Power Demands

Maximum horsepower will probably increase as roads are improved and driving speeds rise.

People will move their homes out of city centers. Outlying shopping centers will spring up. Cars will approach them at highway speeds over good modern roads instead of over today's narrow, slow city streets. Even city travel will speed up. The Los Angeles "Mixmaster" is an example of what we will see all over the country. As a result of all this, drivers will want plenty of reserve power for accelerating and hill climbing in the 30–60 mph range.

To give drivers this reserve power in the driving range in efficient and smooth-running engines, car makers will have to increase maximum engine horsepower. A byproduct—perhaps an unfortunate byproduct—of improved performance in the normal driving speed range will be higher maximum level-road speeds.

Powerplant Type

The gas turbine powerplant will appear in production passenger cars sooner or later. The question is when.

When it does appear, the turbine engine plus its transmission may not cost any more than a corresponding piston engine plus its transmission. This conclusion is supported by the fact that the published driveshaft torque curve of a gas turbine with two-speed transmission is about the same as the curve for a typical piston engine with four-speed transmission. The lower cost of the gas turbine's simpler transmission may balance the turbine's higher cost.

Power for Accessories

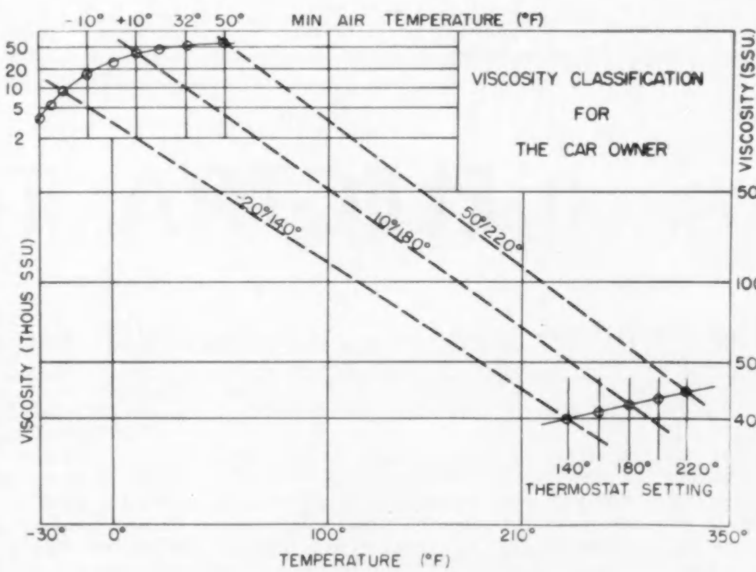
A central hydraulic or pneumatic servo-power system may drive all or almost all power-consuming accessories.

Crowding of engine compartments by power brakes, power steering, and air conditioning may speed the adoption of such a system. It could power brakes, steering, windshield wipers, adjustable seats, and even thermostatically controlled fans. Possibly it would drive the air conditioning compressor also.

Based on paper "What Price Performance" presented at SAE Chicago Section, March 8, 1955.

New Viscosity Classification

Suggestion for Engine Oils



If experience with the multigrade type of oil designation does not clarify its use, it may be wise to consider changing the viscosity classification into terms more generally understood by the car owner and service station attendant.

One way to do it would be to designate oil viscosity characteristics by two temperatures: the lowest expected temperature at which a start is desired and the temperature setting of the water thermostat in the cooling system. Both of these temperatures the car owner has.

The chart shows what might be expected of oils designated this way. In the upper left-hand corner is indicated an often accepted relation between oil viscosity and temperature permitting engine cranking and starting.

The chart indicates also a relation between outlet water temperature and oil temperature on the cylinder walls and a minimum desired viscosity for these operating temperatures. It's possible that the various engine manufacturers and oil technologists could reach agreement on such a relation. (Several investigators have shown that the temperature of the oil on the cylinder wall is closely related to the temperature of the water in the water jacket.)

Importance of the temperature of the oil on the cylinder wall lies in its effect on oil consumption, ring scuffing, and cylinder scoring.

The advantage of this system is that whenever automotive engineering or petroleum technology or both improve their products, the new oils could easily be fitted into the designation system. Car owners and service station attendants would have no need to learn a new system.

For complete paper (in multilith form) on which this abridgment is based, write SAE Special Publications. Price: 35¢ to members, 60¢ to nonmembers.

DESIGNED TO FLY THE SHORT, REGIONAL ROUTES, as well as continental nonstops, the Electra is scheduled to start test flights late in 1957.

ELECTRA: Turboprop

The Airframe

The Electra is a thoroughly conventional airplane—in everything but its turboprop engines. It has low wings, a circular cross-section fuselage, and—unlike the Constellation—a single tail.

The low-aspect-ratio wings have a Lockheed adaption of a new NACA airfoil section, data for which have not yet been released. Wing area is 1300 sq ft. Designers did consider a high-wing configuration for the Electra, but they decided against it. (For one thing, they didn't want passengers to be below the water surface, in case of ditching. For another, they know that pilots like to be able to look out from the cockpit to check wing tops for ice and snow just before take-off.)

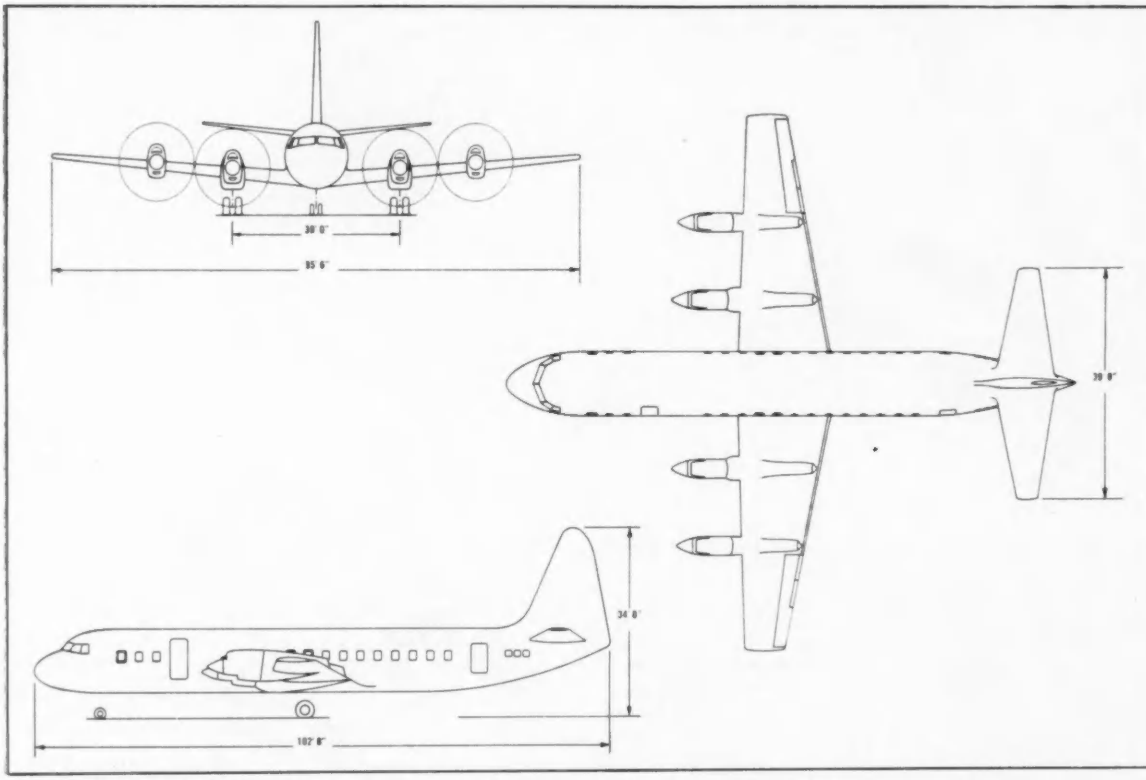
Fuselage diameter is the same as the Constellation maximum—128 in. inside. This gives plenty of room for seating 85 passengers five abreast in the Standard version. The more luxurious Custom version seats 66 passengers four abreast. Both the Standard and the Custom versions have six-passenger lounges, in addition to the forward-facing seats.

The cabin is pressurized to 8000-ft pressure at 30,000 ft altitude. The "picture windows" are rounded-corner rectangles 20 in. high by 16 in. wide.

The Electra won't be dependent on mobile stairs at airports. It has its own stairs built into main cabin exit doors.

The flight station of the Electra cockpit is considerably roomier than that of the Constellation. There is space for three men to sit and work comfortably, plus a seat for an observer. The flight engineer sits facing forward between—and just rearward of—the pilots, following the recommended practice for an SAE Type II standard cockpit. All three can see the same instrument panel. (Lockheed engineers have hopes that the turboprop engines will prove themselves so reliable that there'll be no real need for a flight engineer. Foreign users not operating under Civil Aeronautics Administration rules might choose not to have flight engineers. The weight of the airplane does, however, put it into the category of transports for which present CAA rules require a flight engineer.)

The landing gear will fall free upon release and lock into place without hydraulic-system actuation, in case the hydraulic system fails.



SINGLE-TAILED ELECTRA'S FUSELAGE is of constant circular cross-section from just aft of cockpit almost to rear cabin door.

Transport for 1958 Delivery

Hall L. Hibbard, Vice-President, Engineering, Lockheed Aircraft Corp.

Based on presentation before SAE Metropolitan Section, Dec. 1, 1955, reported by Henry Wakeland, Assistant Field Editor.

The airframe is being designed as far as possible on the fail-safe principle. That is, there will be several parts to carry a particular load instead of just one. If one part fails, the remaining members can still carry the load. The plan is to test the fuselage in small sections under fatigue loading. This appears to be more revealing and less expensive than underwater fatigue testing.

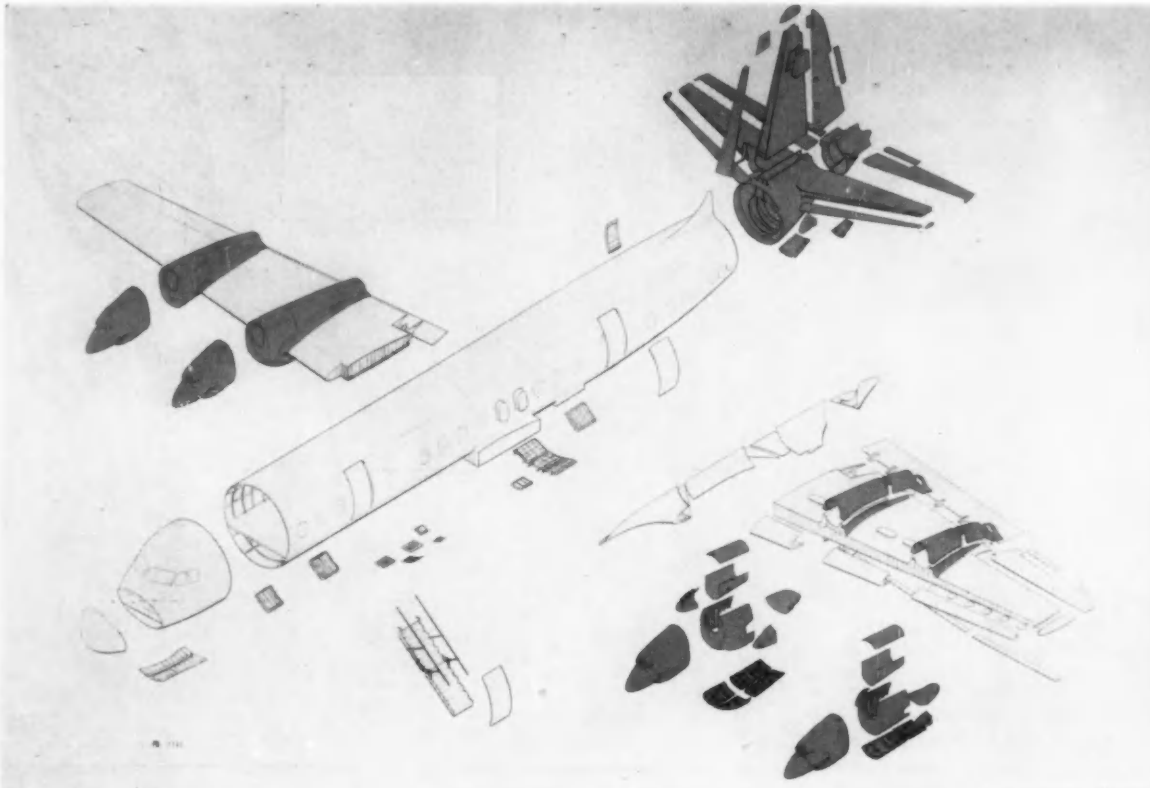
Maintenance and servicing points have been grouped into four areas to avoid congestion on the ramp and to speed up the work. Engineers have studied mockups of the plane and all its ground servicing and baggage equipment to work out the most efficient arrangement of the plane's accessories and hatches.

Whether there is to be single-point or two-point fueling has not yet been decided.

CONTINUED ON NEXT PAGE

Specifications of the Electra Turboprop Transport

Weight empty	54,000 lb
Weight of operating equipment	2,817 lb
Operating load	56,817 lb
Payload	20,600 lb
Fuel reserve (1040 gal.)	7,080 lb
Trip fuel (4160 gal.)	28,280 lb
Design gross take-off weight	110,000 lb
Design landing weight	93,370 lb



SUBCONTRACTORS WILL MAKE MAJOR SECTIONS of Electra airframe. Tail sections will be produced by Northrop Aircraft, Inc.; power packages, including nacelle and tail pipe installations, by Rohr Aircraft Corp.; wing flaps and ailerons by Temco Aircraft Corp., and landing gear (not shown here) by Menasco Mfg. Co.

The Engine

First Electras off the production line will have Allison 501-D13 (T56) turboprop engines and hollow steel Aeroproducts propellers. Later there may be another version powered by some British turboprop and aimed particularly at Empire markets.

The Allison 501-D13's will have the advantage of hundreds of thousands of hours of flight service in over 200 C130 Air Force cargo planes expected to be flying by the time the Electra goes into service. The 501 will also have the benefit of extensive test flying in the original Lockheed Constellation flying testbed.

WOODEN MOCKUP was built to enable Lockheed engineers to try out various interiors and service facilities. In addition to this fuselage model, a complete pilots' cockpit will afford pilots a chance to check on optimum locations of flight station equipment before design is finalized.

Each of the Electra's four Allison 501-13 turboprops delivers 3750 hp for take-off. The installation is designed so that the gearbox output shaft and the propeller hub are below the centerline of the engine. This provides a more efficient airflow into the engine. Besides it puts the air intake high above the ground and lessens the ingestion of dirt.

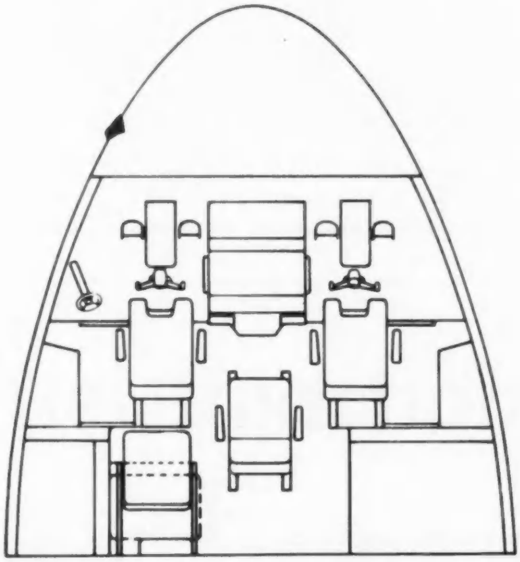
Two British engines are under consideration for the Electra. They are the Rolls-Royce RB 109 two-spool turboprop and the Napier Eland. Lockheed expects to select one of the two soon and, if it develops satisfactorily, to offer Electras equipped with it for delivery in 1960 or 1961.

Operating Characteristics

The Electra is designed to cruise at over 400 mph. It can operate in and out of 5000-ft-runway airports. Its turboprops give it a high block speed even on relatively short hops.

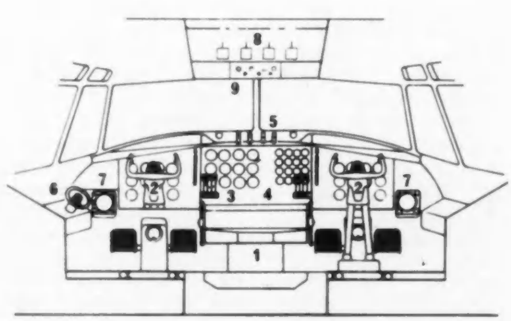
For the Standard (85-passenger) Electra, direct cost per seat-mile will be about 1.25¢ for 500-mile domestic flights and 1.1¢ for 2000-mile flights. For the Custom (66-passenger) Electra, cost per seat-

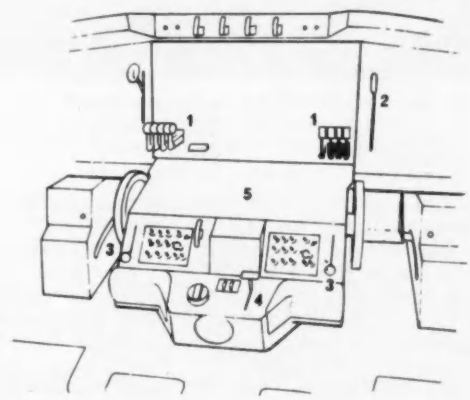
Electra's Cockpit



Electra's cockpit conforms to the basic controls and seating arrangement established by SAE Committee S-7, Cockpit Standardization. Cockpit accommodates a three-man flight crew, plus an observer. The flight engineer is stationed between and slightly aft of the pilot and co-pilot, following the recommended practice for an SAE Type II cockpit. The observer's seat is located behind the pilot and is slightly raised to provide good visibility. It can be readily put aside when not in use.

Emergency controls are accessible to all three crew members. However, they are placed for safe and convenient operation by two men, should one of the crew be absent. Landing gear and flap controls are provided with distinctive handles, and are well separated to guard against inadvertent actuation.





1. *Control pedestal*
2. *Control column*
3. *Automatic pilot*
4. *Engine instruments*
5. *Fire extinguishing*
6. *Ground steering*
7. *Weather radar scopes*
8. *Condition levers*
9. *Fuel control panel*

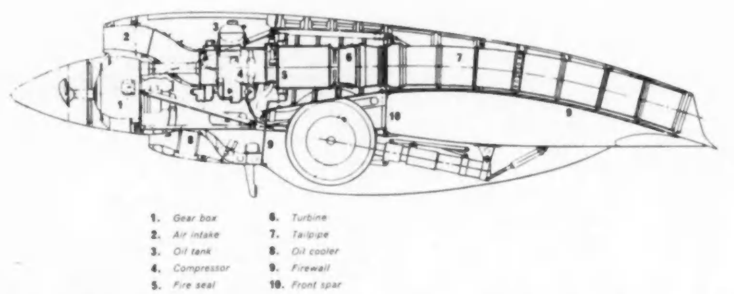
1. *Power controls*
2. *Landing gear*
3. *Flight idle gate release*
4. *Flap controls*
5. *Radio controls*

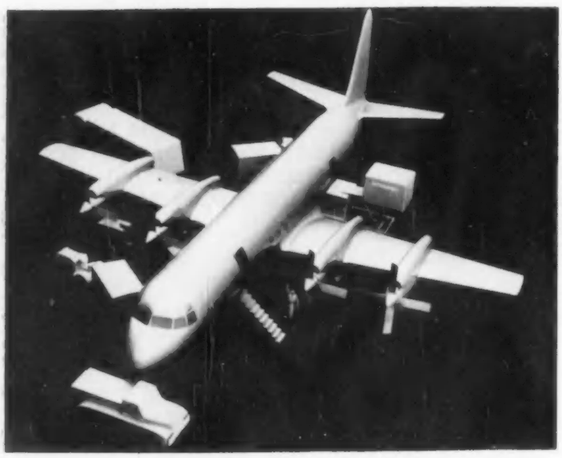
POWERPLANT INSTALLATION is designed to provide ready accessibility for all areas of the engine and accessory compartments. Oversize hinged panels forward of the firewall provide access to the compressor, gearbox, engine accessories, and the oil tank. These panels are secured with quick-opening latches. Both panel sections may be readily disconnected at the hinges and removed. Large panels provide access to the turbine section and tailpipe aft of the firewall.

Each powerplant is installed in a "quick engine change" unit and may be installed or removed complete with accessory equipment and propeller. By removing the turbine access cover, disconnecting all firewall connections, and removing four engine bolts, it's possible to raise the complete powerplant clear of the nacelle for removal.

All powerplants are interchangeable across the airplane except for a small number of engine-mounted accessories which are peculiar to engine location, and which therefore must be handled separately.

The design configuration is one that can grow as more powerful engines become available. With minimum changes there will be room for larger engines, for even greater speeds.





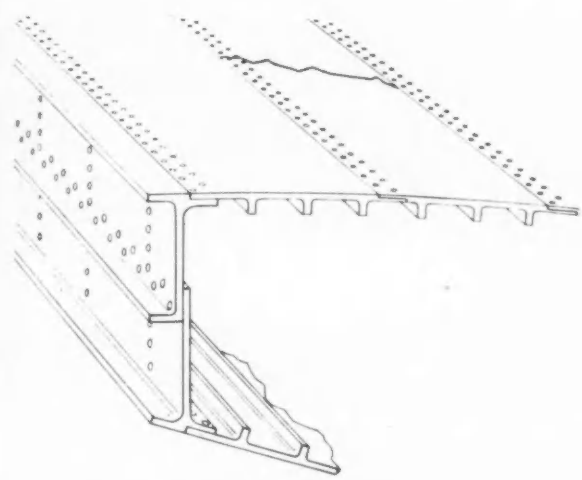
SERVICING WILL BE SMOOTHER because the Electra's designers worked out arrangement of plane's facilities for handling fuel, luggage, cargo, food, and similar items with actual scale models of the transport and the vehicles.

mile will be about 1.75¢ for 500-mile flights and 1.5¢ for 2000-mile flights, Lockheed estimates.

The Electra was designed primarily for regional service—that is, New York-Chicago, New York-Boston, San Francisco-Los Angeles, and flights in that range. But it is capable of crossing the country nonstop—and of operating economically between stops as close as 300 miles.

Although the Electra was definitely not designed to compete with turbojet transports on transcontinental runs, it will initially go into service on relatively long hops, it is expected. Eastern Airlines plans to use their Electras on New York-San Juan and New York-Houston flights for the first year or so until their new turbojet transports are delivered.

Lockheed counts on selling 400 or more Electras in the initial phase of the jet transport race. Statistics show that 75% of airline passengers travel only 500 miles or less. The Electra is designed to serve that huge market.

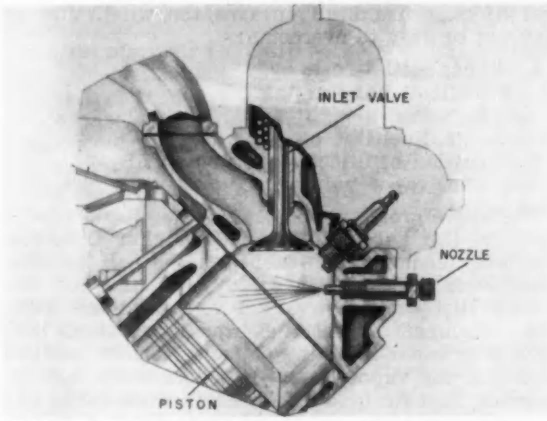


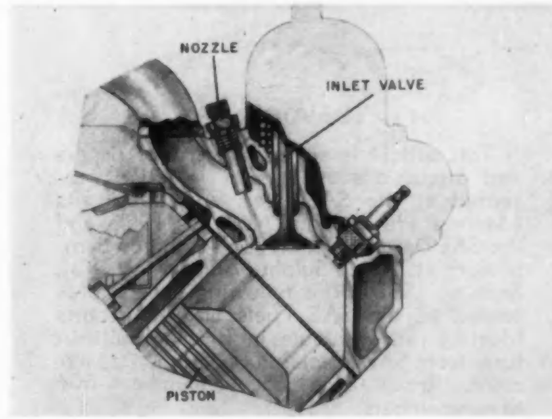
SEPARATE STRIPS STOP CRACKS, as part of fail-safe design. The wing box beam is composed of extruded and machined integrally stiffened surfaces supported by truss-type ribs, and front and rear spars built up from machined sheet webs with riveted-on stiffeners external to the box. The use of low tension stresses in the lower surface and integral skin reinforcing panels constitute an effective means of minimizing the propagation of fatigue cracks.

Each surface is broken into spanwise panel strips approximately 20 in. wide so that if a crack originates in, and propagates across any one panel, the remaining panels have sufficient strength to support flight loads without failure.

Sturdy spanwise joints between lower surface panels are designed to preserve the structural integrity of the box beam under such conditions. Leading and trailing edge structure is carefully coordinated with the box beam structure so that direct paths are provided for all loads.

The crack stoppers are one of many applications of the fail-safe design philosophy in the Electra. Idea is to arrange structural elements so that failure of one element cannot result in failure of the complete structural component.





FUEL INJECTION may be directly into the combustion chamber (left) or into the intake port behind the inlet valve (right.) These are only two of the many design variables engineers must cope with in designing . . .

Fuel Injection For Gasoline Automobiles

DESIGNING a fuel-injection system for gasoline automobile engines involves much more than merely substituting an injector pump for a carburetor. Fuel may be injected directly into the combustion chamber, or into the intake port behind the intake valve, or at other points along the intake manifold. It may be metered on the basis of engine speed and intake manifold pressure, or as a function of intake airflow velocity. It may be supplied in timed, measured amounts or in a continuous flow, through separate lines to each cylinder or through a common "rail." It may be metered by positive-displacement injection pumps, by distributor valves, or by the use of a "pressure carburetor."

With so many basic design possibilities, it is easy to see why there are so many different fuel-injection systems. Each design claims certain advantages over the other systems. But before we compare them, what are the advantages of fuel injection over carburetion?

Pros & Cons

According to engineers who favor fuel injection we can expect quite a few advantages over the carburetor system:

1. Increased power output at high engine speeds.
2. Increased torque output at low engine speeds.
3. Quicker cold starting and warming up.
4. Elimination of carburetor throttle plate icing.
5. No backfiring.
6. Reduction of unburned hydrocarbons in the exhaust during deceleration.
7. Wider latitude in the use of fuels.
8. Improved liveliness in response to throttle.
9. Less tendency for vapor lock.
10. Better fuel economy.
11. More room in the engine compartment or lower hood silhouette.
12. Ability to compensate easily for changes in ambient temperature and altitude.

On the other hand, other engineers warn that

This is Part I of a two-part article, "Fuel Injection For Gasoline Automobiles." Part II will appear in the February issue of SAE JOURNAL.

The Authors

This article is an abridgment of papers and discussions about fuel injection presented at the SAE Fuels and Lubricants Meeting, Philadelphia, Nov. 10, 1955, and the SAE Detroit Section Fuel-Injection Symposium at White Sulphur Springs, W. Va., Sept. 9, 1955. The following papers, presented at the SAE Fuels and Lubricants Meeting, are available in full in multilith form from SAE Special Publications Department. Price: (each) 35¢ to members, 60¢ to nonmembers.

Problems of Fuel Injection for Gasoline Automobile Engines

F. C. Mock and W. C. Suttle.
Bendix Products Division, Bendix Aviation Corp.

Automotive Gasoline Injection

S. E. Miller,
American Bosch Division, American Bosch Arma Corp.

A special publication SP-140 compiled of the five papers presented at the Fuel-Injection Symposium is available from the Special Publications Department. Price: $1.50 to members, $3.00 to nonmembers. The authors are:

E. J. Gay, Technical Consultant
E. A. Lindblom, International Harvester Co.
A. L. Pomeroy, Thompson Products, Inc.
E. K. Von Mertens, American Bosch Arma Corp.
J. E. Taylor, Gulf Research and Development Co.

Discussion

The following authors contributed discussion on the above technical papers. The material has been incorporated in the accompanying article.

H. M. Gammon, Thompson Products, Inc.
N. R. McManus, Ford Motor Co.
W. S. Dack, C.A.V. Division, Lucas Electrical Services, Inc.
H. S. Kelly, Socony Mobil Oil Co.
C. J. Livingstone, Gulf Oil Corp.
E. W. Downing, Joseph Lucas Co. Ltd., Birmingham, England
V. G. Raviolo, Lincoln-Mercury Car Engineering, Ford Motor Co.
M. J. Kittler, Holley Carburetor Co.
P. Richards, E. I. du Pont de Nemours, Inc.

fuel injection has disadvantages, too, which may or may not be easy to overcome:

1. Higher initial cost.
2. Difficult hot starting.
3. Noise.
4. Fuel line clogging.
5. Corrosion of injection equipment.
6. Poor vapor-handling capacity.

The above pros and cons are by no means agreed upon in the automotive industry. For instance, estimates on how much fuel injection will increase horsepower vary from 3 to 25%. Claims for improved fuel economy vary between 5 and 15%. Some engineers expect fuel-injection systems will have poor vapor-handling capacity; others see less tendency for vapor lock. It is generally agreed, however, that for best results engines should be designed specially for fuel injection instead of merely substituting an injection system for a carburetor.

How Advantages Are Achieved

Regardless of the type of fuel-injection system used, better all-round performance can be expected because fuel injection permits more precise control of the amount and timing of fuel delivery than a carburetor system does.

In carburetor systems there is a necessary design compromise in making the manifold large enough for easy breathing and small enough to maintain adequate airflow velocity at idle so that fuel won't settle out and prevent proper mixture ratio. Fuel injection avoids these inherent manifold design problems by delivering just the right amount of fuel at a point closer to the cylinder. There is much less fuel deposited on the manifold wall; so the over-all fuel-air ratio necessary to give an ignitable mixture can be less than that required with a carburetor. This gives better fuel economy.

Most carburetor engines rely on manifold heat to help vaporization. Since injection atomizes the fuel mechanically, there is no need for manifold heating devices. With cooler manifold and cooler incoming air a larger amount of mixture can be drawn into the combustion chamber. Thus volumetric efficiency is improved and power output is increased.

With no manifold hot spots there is less possibility of backfiring through the induction system, and less tendency to vapor lock.

Lower intake temperature reduces the engine octane requirements, too. So spark timing can be advanced considerably without causing detonation. The engine compression ratio can be increased giving higher horsepower and better fuel economy. The greatest horsepower increase can be expected at high speeds.

Since fuel injection gives more uniform cylinder-to-cylinder distribution of the fuel, it is possible to use a much leaner mixture at part throttle, thereby improving fuel economy.

Experiments indicate that in an engine equipped with fuel injection, peak torque occurs about 500 rpm lower than with a carburetor. This is particularly advantageous for cars with automatic transmissions.

Some injection systems respond very quickly to engine requirements. So, an automatic device to

cut off fuel during deceleration can be used without affecting engine performance. This will reduce the amount of unburned hydrocarbons which are forced out the exhaust and which contribute to smog. Some fuel economy is achieved too.

Perhaps the greatest difference of opinion regarding the advantages to be derived from fuel injection is among fuel engineers. Some say a properly designed fuel injection system may permit better use of fuel octane numbers, especially with more sensitive fuels. It may also permit the use of more low-boiling and high-boiling materials in gasoline, thus increasing the amount of fuel which can be refined from a barrel of crude oil. Other engineers are more skeptical.

High-boiling-range fuels usually cause engine deposits, spark-plug fouling, and crankcase dilution. It remains to be seen whether fuel-injection systems can permit the end points of gasoline to be increased significantly and still handle these problems satisfactorily.

Theoretically, however, since fuel injection will minimize warmup problems, the refiner will be able to blend in certain high-boiling, high-octane materials. Since the injection system is pressurized, higher-vapor-pressure fuels may be used. Such fuels with their inherently high octane ratings require less tel. If gasolines with less tel are used, combustion-chamber deposits will be reduced. (This lowers the engine octane requirement.)

Either lower octane fuels may be used or, what is more likely, compression ratios may be increased, giving better power and fuel economy.

But, before refiners can take advantage of the greater fuel volatility tolerance, they will have to wait until there are enough fuel-injection cars on the road to make it worth their while.

Perhaps for a few years there will be a "third pump" in gasoline service stations to handle fuel-injection gasoline as well as regular and premium.

Three Basic Systems

Fuel injection systems fall broadly into three general classifications: (1) timed injection, (2) continuous flow, and (3) injection carburetion.

(1) Timed injection

Fuel is delivered in individual, timed charges directly into the combustion chambers or into the intake ports.

Fig. 1 shows a timed injection system which meters the fuel charges by a multiple-unit pump. Fuel is sent under comparatively high pressure through individual lines to each cylinder.

This method allows the fuel-injection system to be handled as an accessory unit, but it presents fuel line inertia problems. At high engine speeds, the lag of starting fuel delivery at the spray nozzle at the end of a 2-ft line may be over 40 crankshaft degrees. So injection pump timing must be corrected at high rpm.

Also at high speeds, when the intake ports close, a sudden pressure rise may surge along the fuel line at 4000-5000 fps. This surge may leave a vacuum behind it, with the result that more fuel goes out of the line than was pumped in. The next charge from the pump is partly used to refill the line. Thus there is a periodic variation in the size of the fuel charges to the same cylinder. This will lower fuel economy.

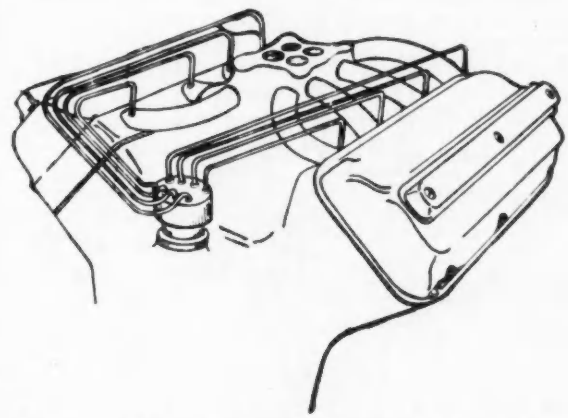


Fig. 1—Timed injection by a multiple unit pump. Fuel is metered and pumped in equal consecutive charges along individual fuel lines to each cylinder under high pressure.

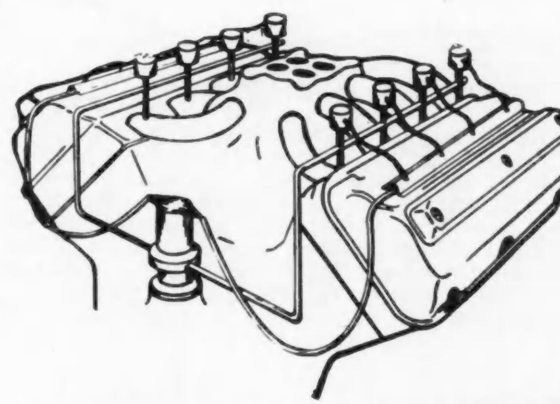


Fig. 2—Timed injection by the "common rail" system. Fuel is delivered through common fuel line to solenoid-operated injection valves which meter charges to each cylinder.

Another problem with timed injection is high fabricating costs due to the required high accuracy of fit. For example, a small variation in the length of the plunger strokes in the metering pump may give considerable variation in the amount of fuel delivered to each cylinder. Also, leakage is possible if the clearance between the plunger and the plunger's cylinder is more than 100 millionths of an inch. Such tight clearances are often easily clogged with dirt. If the plunger is not perfectly round and straight within about 10 millionths of an inch, friction will cause the plunger to expand and seize.

Bendix Products Division solves this problem by using hard but dissimilar materials (such as nitralloy and stellite) for the plunger and its bushing. These two materials have approximately equal thermal expansion and are comparatively noncor-

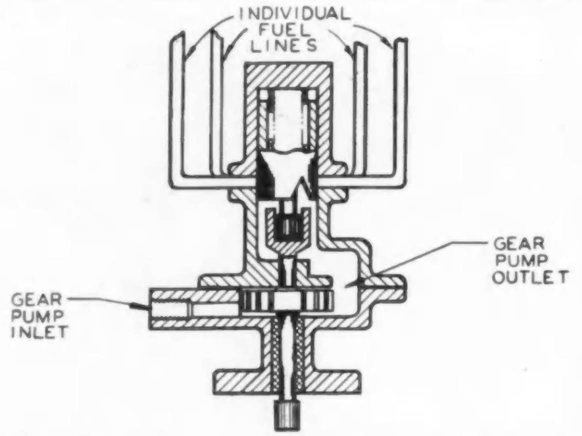


Fig. 3—Typical distributor valve. Fuel may be pumped to timed distributor device, which divides and meters fuel to different cylinders.

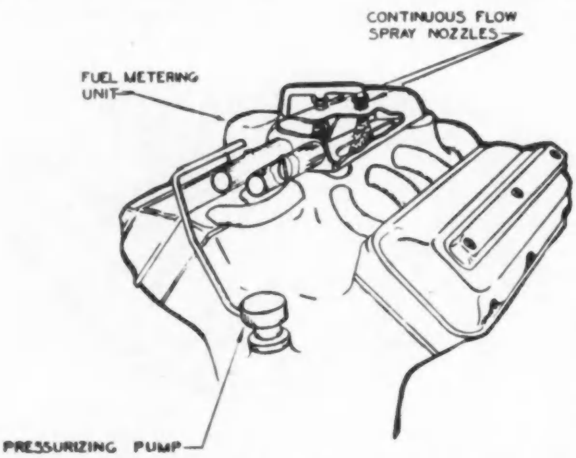


Fig. 4—Fuel delivered by injection-carburetor system. Pressurizing pump delivers fuel to injection carburetor, which meters it and sends it to continuous-flow spray nozzles.

rosive. The fuel port edges are made square so as to reduce clogging.

Fig. 2 shows a timed injection system which uses a common fuel supply line. Cam- or solenoid-operated injection valves near the cylinders meter and time each fuel charge. When this system is properly designed fuel line inertia problems are eliminated. It is doubtful that camshaft operation can be used for automobile engines because of the control difficulties and high cost. Solenoid operation shows some promise.

By using a nonmetering (and less expensive) pump as a source of fuel, and a pressure regulator and some sort of timed distributor device to divide and meter the fuel, cost can be cut considerably. Fig. 3 shows a typical timing and distributor valve. One big problem is dividing the fuel charge accurately to accommodate the inevitable variation in the spray nozzle settings. One solution seems to be to keep the pressure of the fuel at the supply side of the distributing valve so high that a variation of a few psi on the downstream side has little effect.

In this system, at high speeds, there is limited force available to accelerate the line charge at the start of delivery, so the system is very sensitive to variation in the line area, length, or elasticity.

With any of the variations of the timed injection system, fuel may be sprayed directly into the combustion chamber or into the intake port manifold. In the United States it is generally preferred to spray the fuel into the intake port to be carried into the cylinder by the air. Below about 5000 rpm there is little difference in performance between an engine using direct injection and one using port injection. However, at 5500 to 6000 rpm, the inlet valves are open such a short time that injection timing and duration must be extremely accurate and short with port injection. So at these high speeds, the direct method permits fuel injection during the full time of the intake stroke and some part of the compression stroke, too. This is one reason why high-speed racing cars like the Mercedes 300SL use direct injection.

Some of the problems and high cost of the timed

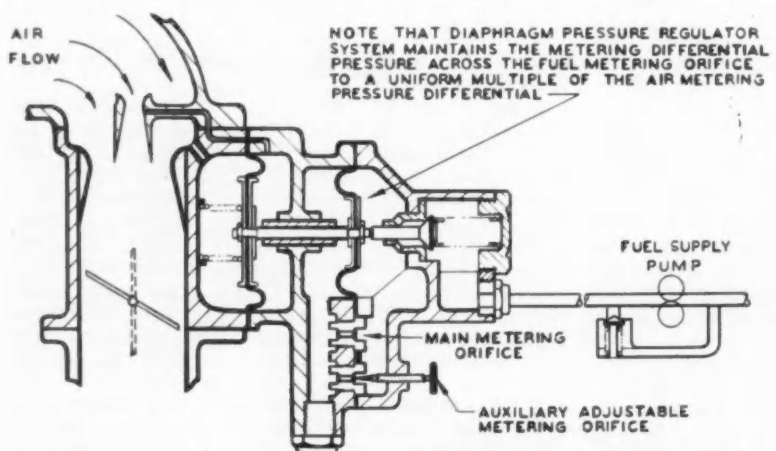


Fig. 5—Fuel metering by air velocity in pressure carburetor. Fuel from tank is admitted to special chamber in injection carburetor. Fuel pressure and flow is metered according to airflow and then passed on to nozzle, fuel divider, or to injection pump.

injection system can be avoided if we use divided, but continuous, nontimed injection.

(2) Continuous-flow injection

In this system most of the fuel is delivered continuously into each intake port during the nonsuction strokes of the engine cycle. It is drawn into the cylinder when the intake valve opens on the intake stroke. This eliminates fuel line inertia, but the metering orifices must be made very small (about 0.006 in.) because the fuel is constantly "dribbling" in. A major problem in this system is to keep the fuel from boiling in the lines during manifold depression at idling and part throttle.

(3) Injection carburetor system

In the ordinary carburetor, fuel is metered and delivered into the airstream by the same pressure potential and at practically the same point. If these two functions are separated—as in the injection carburetor—we can do several things to improve performance: Fuel metering force can be amplified, fuel can be delivered at any point in the system, and additional energy for atomizing the fuel can be supplied. Fig. 4 is an illustration of an injection carburetor system.

Fuel is fed to the carburetor from a pump located in the fuel tank. Then fuel is metered and supplied to a supplementary pump that repressurizes it and sends it to a nozzle above the throttle valve. Injection at this spot avoids icing.

Pressure carburetors for passenger-car engines give almost complete freedom from carburetor icing. Also, they are quite insensitive to hot fuel problems and the changing conditions of quick stops and sharp turns.

With any of the systems—timed, continuous, or injection carburetor—proper air-fuel ratios must be maintained during variations in engine load with speed. There are two well-known ways of controlling fuel/air ratios which can be applied to any of the injection systems just discussed.

Controlling Air-Fuel Mixture

The size of the fuel charge delivered to the cylinder can be metered as a function of:

(a) Mass airflow.

(b) Engine speed and the density of the air charge.

A good fuel-injection system must also be able to enrich the mixture for starting, for idling, and for full throttle or full load. Due to the inherent lag in using an air throttle, provision must be made to prevent a momentary lean mixture when stepping on the gas suddenly. And a mechanism should be provided to cut off fuel during deceleration to prevent exhausting unburned hydrocarbons into the atmosphere.

Metering by airflow The injection carburetor (Fig. 5), currently being used in aircraft engines, is an example of metering fuel according to the velocity of the intake air.

Fuel under pressure from the fuel supply pump is admitted to a special chamber of the carburetor.

A combination of diaphragms controls the rate of flow and/or pressure of the fuel, as yet unmetered, into another chamber. Two diaphragms sense the venturi suction (which is proportionate to the air velocity). Another diaphragm measures the pressure differential across fuel metering orifices. These diaphragms are linked together to operate

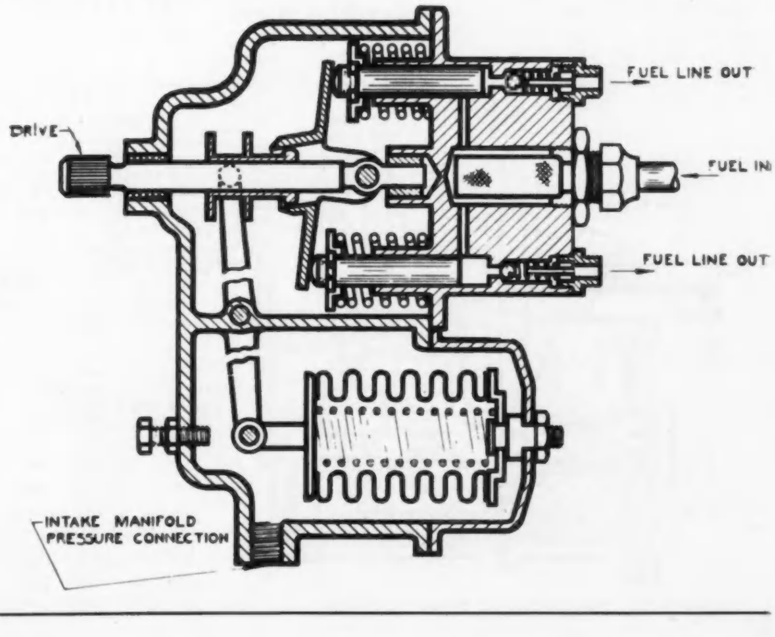


Fig. 6—Fuel metering by manifold pressure and engine speed. Engine speed for timing is picked up through mechanical linkage.

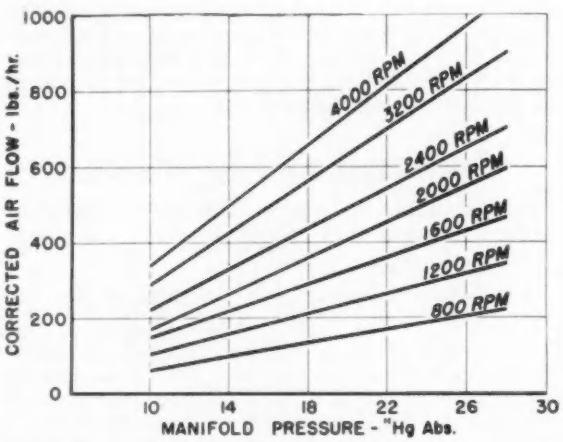


Fig. 7—Manifold pressure is a reliable measure of mass airflow over entire speed range. Changes in manifold air temperature must be compensated for, however.

a valve which controls the pressure and rate of flow of the fuel to the second chamber.

Fuel is then passed through calibrated orifices which provide full power and cruise regulation. Then it is sent to the injection pump and thence to the inlet manifold or the individual cylinders.

Since control is entirely independent of the location, form, pressure, or other characteristics of fuel discharge, this system is adaptable to many installations. Fuel and air orifices are fixed. Metering functions naturally under many different conditions.

Metering by engine speed and air density Fig. 6 is a typical mechanism for metering fuel according to engine speed and air density. The speed factor is imposed on the pump directly from the engine.

As a measure of air density, manifold pressure can be used, *if* compensation for temperature is made. Fig. 7 shows that manifold pressure is a reliable indicator of mass airflow at constant temperature over the entire speed range. The effect of increasing temperature on air density is quite significant, however. For example, at 0 F manifold temperature, an engine may pump 145 cu ft of dry air for every pound of fuel, maintaining a 12.5/1 air/fuel ratio. To hold the same air/fuel ratio at 160 F, the engine must induct 195 cu ft of dry air for every pound of fuel. Since the engine is essentially a constant-volume pump, this additional air cannot be inducted and the air/fuel ratio is lowered. Hence some means must be provided to correct the fuel flow for changes in manifold air temperature.

Also, changes in barometric pressure and in altitude can cause significant errors in fuel flow if they are not compensated for.

Fig. 8 shows another method of manifold pressure metering. The engine rpm factor is obtained by the rise in pressure across an engine-driven centrifugal pump, acting across a metering orifice. Orifice area is controlled by the intake pressure.

Fuel Injection Systems Vary in Cost

From the foregoing description of the various types of fuel-injection systems and the problems indigenous to each, it should be obvious that costs will vary considerably, depending upon the performance required of the system. It is estimated that a timed injection system can be mass-produced for about $100 although some systems may cost as high as $300. Continuous-flow systems probably will be much lower. In general, manifold injection costs less than direct-into-the-cylinder injection. Using a nonmetering pump with a distributing valve will probably cost less than a multiple-unit, metering pump.

A full description of several existing fuel injection systems, and the way in which they solve cost and other problems will appear in the next issue of the *SAE Journal.*

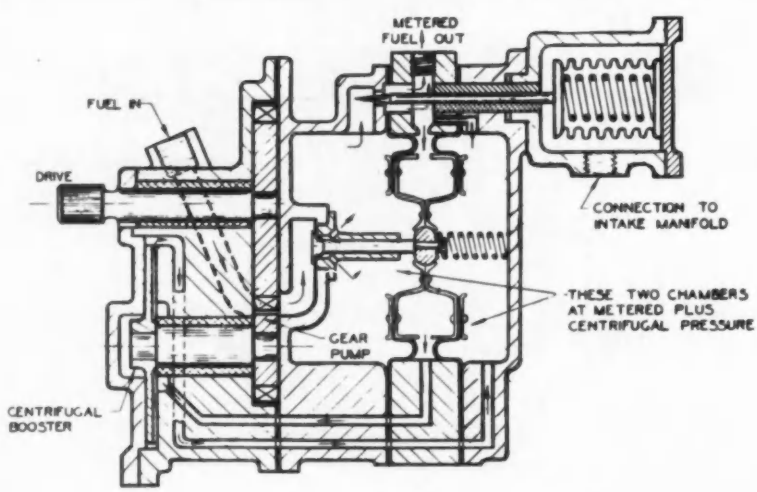


Fig. 8—Centrifugal form of intake pressure metering.

How to Take the ROAR Out of the Lion—or

"Silencing the Jet Engine Is Now Possible"

John Tyler and George Towle,
Pratt & Whitney Aircraft, Division of United Aircraft Corp.

Based on paper, "A Jet Exhaust Silencer" presented at SAE Golden Anniversary Aeronautic Meeting, April 19, 1955. This paper will be published in full in the 1956 SAE Transactions.

THE roar of the jet engine can be silenced! It's done with an exhaust silencer that contains many small nozzles to raise noise frequency so high that most of it is above the audible range.

Already it is being successfully used to silence jet engines during ground testing. And there is every reason to believe that the idea can be adapted for use on aircraft in flight.

Ground Silencer

A perforated sheet-metal ground silencer has been extensively tested on a jet engine mounted on an outdoor test rig. Fig. 1 shows some of the test results. Note that it gives patterns of take-off noise levels for:

(a) The jet engine without silencers.

(b) The jet engine with both intake and exhaust silencers.

(c) The jet engine with exhaust silencers only. (This curve has been estimated.)

(d) A DC-6 powerplant.

This graph shows that the noise pattern for the silenced jet engine would be satisfactory for most ground testing operations.

The silencer used in these tests was made oversize—7 ft in diameter and weighing 1000 lb—to ensure no appreciable intake pressure drop when using square-cornered panels. Obviously, before this type of silencer would be built in production quantities, a much smaller and lighter construction would have to be developed to give the same noise attenuation and pressure drop.

The silencer consists of a perforated sheet-metal tube attached to the nozzle of the jet engine. The end of this tube is closed with a cone of the same perforated sheet metal. The holes are 0.085 in. in diameter, spaced 3 diameters apart so as to keep the wakes of the individual nozzles properly separated.

This tube acts as a diffuser. The exhaust gas, escaping through the holes allows the exhaust stream to expand as it flows rearward. This provides pressure recovery and the development of a pressure head in the tube.

Use of the proper effective nozzle area for the tube (that is, the proper amount of surface area of perforated sheet metal) allows the pressure rise through the diffuser to be adjusted to be equal to the pressure drop through the perforated sheet metal for a given exhaust flow. This provides ambient pressure at the discharge of the engine nozzle.

This can be done by using an unperforated sheet-metal band at the rear end of the tube. The tube is made slightly oversize and the band adjusted forward and backward until the proper amount of perforated sheet-metal surface is exposed.

Actually, the addition of the silencer changes the flow characteristics of the jet-engine nozzle. The silencer area may, however, be adjusted so that, at a given operating condition, say at take-off thrust, the engine operates the same with the silencer as without. At lower airflow, the combination of nozzle and silencer acts like a nozzle of smaller diameter. This

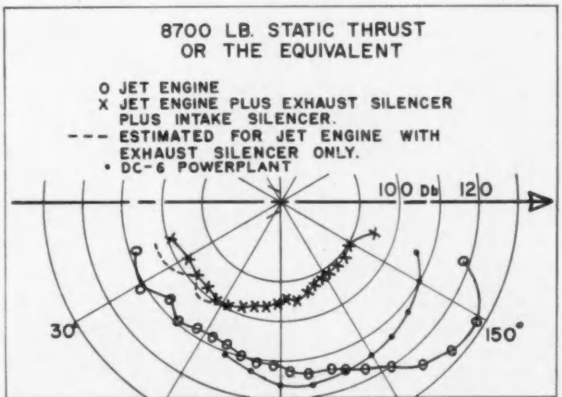


Fig. 1—Contour plot of overall noise levels along 150-ft radius-arc.

may, however, be satisfactory for ground running purposes.

The perforated tube exhaust silencer should also have a quick-disconnect clamping ring to fasten it to the nozzle. In most airplane installations, a shroud would be needed around this silencer to collect the hot gases and blow them rearward and away from the structure. Otherwise, they might overheat parts of the airplane. Such a shroud has but a minor effect on the noise coming from the silencer.

In the tests, the engine was also equipped with an intake silencer to prevent the compressor noise from interfering with the exhaust noise measurement. The intake silencer consisted of a solid disc in front and a series of washer-shaped sound-absorbing panels mounted on a bellmouth engine air inlet.

Flight Silencer

While the perforated sheet-metal tube ground silencer is very effective in reducing noise, it provides negligible thrust. Reason: the hot gases are exhausted in a radial direction with respect to the thrust axis, rather than rearward.

Exhaust nozzles have, however, been built to accomplish both these purposes. They have an overall shape the same as the perforated sheet-metal tube used in the ground silencer, but the gases are exhausted through a hole at the rear of small protrusions in the surface of the cylinder, as shown in Fig. 2. Tests have been made with individual scale-model nozzles having this shape and having thrust coefficients the same as the full-scale conical nozzle on the engine.

There are two factors, however, that tend to reduce the overall thrust from a multiple nozzle of this type.

(1) The individual nozzles must be pointed slightly outward from the surface of the silencer, so that the jet wakes will not impinge on other nozzles immediately downstream and so that the wakes will not mix with the wakes from other miniature nozzles in the same area.

(2) The flow patterns of these wakes and the induced secondary airflow at the surface of the silencer involve pressure distribution patterns on the surface of the silencer which affect the thrust.

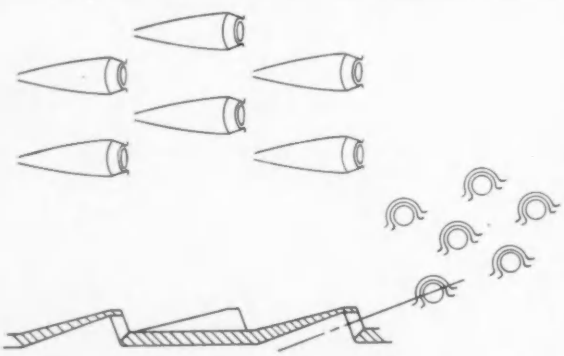


Fig. 2—Thrust-producing small nozzles in surface of cylindrical silencer.

A great deal of work has been done using scale-model nozzles set at 20 deg to the thrust axis. Since the cosine of this angle is 0.94, this would represent perfection for this arrangement. Actually, the test results scatter a few per cent below this value.

No noise patterns, noise power levels, or spectra are presented for the flight silencer. These values depend on the spacing and pattern of the miniature nozzles on the silencer surface as well as their size and shape. The relationship between the silencing effect of this device and its weight and effect on thrust must await the results of further studies.

To prevent the silencing thrust loss from affecting cruise economy, the configuration shown in Fig. 3 could be used. In this arrangement the silencer elements are stowed like sections of a collapsible drinking cup around the tailcone for the cruise condition. Thus clean internal and external lines are provided for airflow through the exhaust duct and over the engine fairing for normal flight conditions. For take-off and climb the tailcone and silencer sleeves are extended rearward and the cruise nozzle is closed. This forces the exhaust to be ejected through the large number of small, rearward-pointing nozzles in the surface of the silencer sleeves. After the airplane has climbed to an altitude where the noise will not be objectionable on the ground, the silencer is retracted and climb is continued using the conventional nozzle. The air-speed at the time of retraction will probably not be over 200 mph.

Use of the silencer for take-off would be at the option of the pilot, of course. If the airplane takes off from an airport where high noise level is permitted or at a time of day or in a direction such that the noise is not objectionable, the take-off could be made without the use of the silencer and, therefore, without thrust loss. Some of these conditions might allow an airplane to make transoceanic flights at maximum gross weight without the silencer, whereas the bulk of the flying from our busy airports could be with the silencer in use.

For complete paper (in multilith form) on which this abridgment is based, write SAE Special Publications. Price: 35¢ to members, 60¢ to nonmembers.

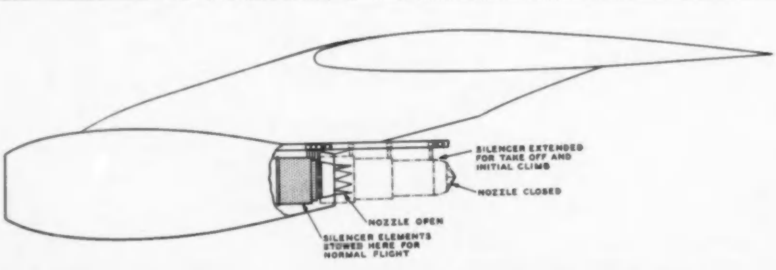


Fig. 3—Proposed exhaust silencer for jet engine in flight.

Streamlined Maintenance Cuts Costs . . . of Truck, Tractor, and Trailer "Down" Time

W. A. Taussig, Vice-President, Burlington Truck Lines, Inc.

Based on paper "Streamlined Maintenance Cuts Costs" presented at SAE Golden Anniversary Transportation Meeting, St. Louis, Oct. 31, 1955.

BURLINGTON has found that a dynamic maintenance program improves workmanship and reduces "down time" and maintenance labor hours. Factors which have aided in achieving these ends include:

1. Vehicle maintenance control
2. Service trucks
3. Tarpaulin repair
4. Scaffolds
5. Welding
6. Lettering
7. Unit rebuilding
8. Tool and instrument maintenance
9. The parts department

Vehicle Maintenance Control

A Vehicle Maintenance Control Board provides a current and constantly visible record of inspections. It assures that vehicle inspection is made at proper intervals. Fig. 1 is a picture of such a board.

The board is divided into two main sections. On the left are highway tractors and trailers and on the right are city delivery trucks, tractors, and trailers. Vehicles are grouped on the board by station assignment. The right side of Fig. 1 shows the city units assigned to Cicero, Denver, Galesburg, and Omaha.

On the highway side of the board, each column represents one week. On the city side, each column represents one month. When a minor inspection has been completed on a highway unit, a white star is placed in the column representing the week of inspection.

If a month goes by without the white star moving along, it is known that a month has elapsed since an inspection has been performed. The offending shop is traced and a yellow star placed on the board.

A red star next to the unit number signifies that

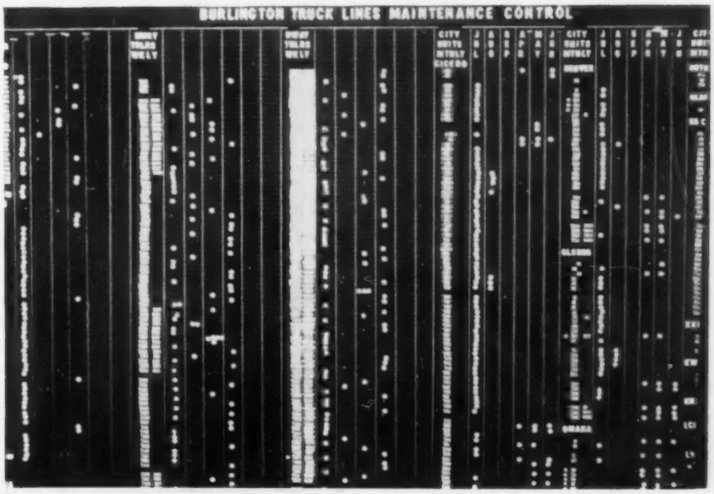


Fig. 1—A vehicle maintenance control board of this sort permits concise visual inspection of the maintenance status of all vehicles. It permits shop scheduling and policing of delinquent vehicles.

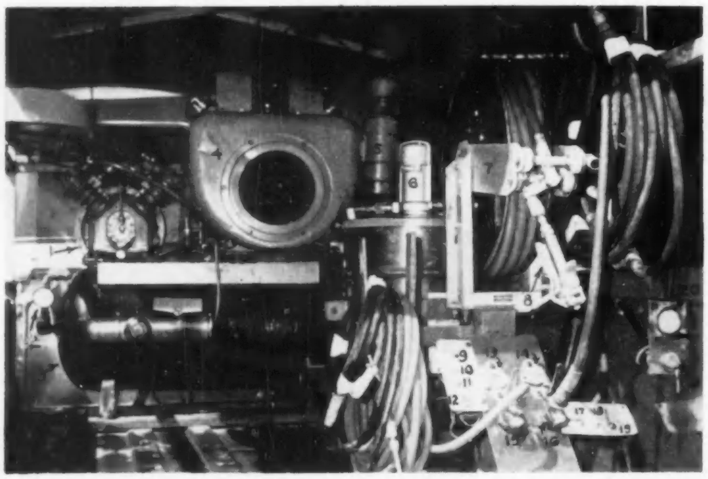


Fig. 2—Service trucks enable minor weekly inspections to be made on the road. Typical equipment carried by one of these trucks includes: 1. air compressor 8 cu ft at 300 rpm 2. air pressure gage 3. air reservoir 4. air cooled gas engine—20 hp at 2200 rpm 5. air cleaner for gas engine 6. lubrication pump 7. spring loaded reel for lubrication hose 8. grease gun 9. switch for 12 volt marker lights 10. switch for 12 volt stop lights 11. switch for 12 volt right turn signal 12. switch for 12 volt left turn signal 13. receptacle for 12 volt cable to trailer 14. receptacle for 6 volt cable to trailer 15. angle cock for tire inflation air 16. angle cock for air to test brakes or operate power tools 17. switch for 6 volt marker lights 18. switch for 6 volt stop lights 19. double throw switch for 6 volt right and left turn signals 20. ammeter for 12 volt generator driven by gas engine 21. ignition and starter switch for gas engine.

the unit is out of service. A red star inserted in a column means that a major inspection has been performed. Major inspections are set up on a mileage rather than on a time basis.

Service Trucks

Because trailers are not usually assigned to definite runs within their home shop territory, minor inspections become a problem. We have solved this problem by taking the shop to the trailer. This is done by service trucks. Fig. 2 shows some of the equipment carried by one of these trucks.

Tarpaulin Repair

By using nylon instead of canvas, sewing is eliminated in the repair of tarpaulins. Repairs are made by cementing patches onto the damaged portion. Repair in Chicago, which formerly ranged from $300 to $500 per month, costs about $75 per month for the new covers.

No special equipment is required for repair. The process is so simple that repairs can be made by terminal employees at stations where there are no shop forces.

Scaffolds

Labor hours are saved by having mechanics work in comfortable positions on scaffolds instead of working from ladders. A greater degree of safety is also provided. For working on high points of trailers, a scaffold such as pictured in Fig. 3 is used.

Welding

Being equipped to do all kinds of welding avoids costly delays. Modern equipment requires various types of welding. Oxy-acetylene welding appears to be most adaptable to cutting and brazing. Arc welding is adaptable to bead welding and joining heavy materials.

Resistance or shot welding is very effective in welding stainless steel. A moderately priced set of equipment will successfully weld all stainless steel trailer parts up to about ⅛ in. thick. The same equipment can be used to spot weld high tensile steel of moderate thickness.

Heli-Arc welding can be used for any type of steel. It welds stainless steel of thin or thick section without destroying its non-corrosive characteristics. For heavier sections, the material is drilled and plug welds applied. The equipment can be used for either spot or bead welding.

Lettering

The use of scotchlite lettering and emblems has considerable advertising and safety value. It assures uniform lettering on all units and may be applied at a shop that does not employ a professional sign writer. It is more expensive than hand painting but its life is longer.

Unit Rebuilding

Many devices and instruments are available to cut labor time and improve quality of work in the rebuilding of the various units of the motor vehicle. One handy gadget is an engine run-in stand mounted on wheels. After the engine and its accessories have been rebuilt they are placed in the stand and run for 8 hr at no load.

The speeds are 1000 rpm for 1 hr, 1200 rpm for 1 hr, 1400 rpm for 1 hr, 1600 rpm for 2½ hr, and finally 1800 rpm for 2½ hr. This run seats the piston rings and it is believed that any defects will show up during such a run. The instrument panel of the portable stand is shown in Fig. 4.

With the proper equipment, cylinder bores can now be measured more accurately than before. A new model dial gage reads to 0.0001 in. as compared to the former gage reading to 0.001 in.

Its construction enables the mechanic to measure the entire length of the bore in four positions or every 45 deg in the same time that it formerly took in two positions or at 90 deg. Cylinder bore and ring life has increased as a result of this greater accuracy.

Other equipment consists of such devices as piston

Fig. 3—Scaffolds permit mechanics to work comfortably and safely on large vehicles.

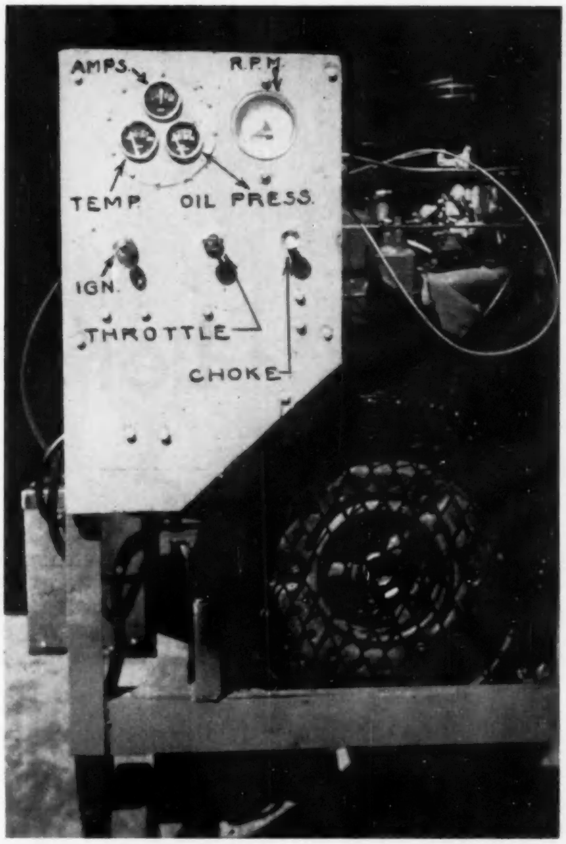


Fig. 4—Control board of an engine run-in stand. The rebuilt engine is placed in the stand and run for 8 hr at no load. This shows up any defects in the engine.

pin clearance gage reading to 0.0001 in., valve seat indicator reading to 0.001 in., valve tester to test concentricity of stem and face and alignment of stem reading to 0.001 in., fixture to test engine main bearing alignment, valve spring testers, various micrometers and dial gages, and various electrical instruments and testers.

Tool and Instrument Maintenance

A definite and protective place to keep each tool and instrument when not in use saves time and money. Tool boards, brackets, and cabinets accomplish this purpose. A cabinet to store front end alignment and wheel balancing equipment is shown in Fig. 5.

The Parts Department

Separate bins for each overhauled unit save time and confusion. The units that adapt themselves to bin storage are starters, generators, distributors, regulators, carburetors, fuel pumps, and clutch assemblies.

The office side of parts supplies should not be overlooked in the operation of a maintenance system. Orderly and efficient parts departments avoid costly excess inventories and even more costly delays due to exhausted supply.

For complete paper (in multilith form) on which this abridgment is based, write SAE Special Publications. Price: 35¢ to members, 60¢ to nonmembers.

Fig. 5—A cabinet for storing alignment and balancing equipment. The cabinet doors can be locked for protecting the equipment when it is not in use.

Let's Integrate Our

INTEGRATION of the group of diverse elements making up today's aircraft instrumentation into an adequate, efficient, and harmonious relation depends on suitable answers for the following questions:

1. What is the airplane for?

2. Who operates it—the man, the machine, or the man-machine combination?

3. How do we present the data?

4. How do we implement the requirements?

What Is the Airplane For?

To integrate any instrument system with the aircraft, it is essential to determine whether or not the system fits the aircraft mission. There are two schools of thought on this subject: (1) those who believe that each aircraft is different not only in mission but that each phase of flight must be treated differently; (2) those who believe that all forms of flight are fundamentally the same. I strongly back the latter school because the equipments used in various types of aircraft, although outwardly inconsistent, are in fact fundamentally the same.

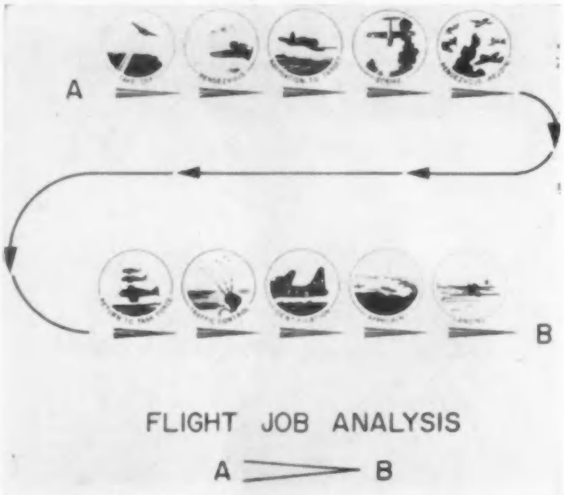


Fig. 1—All flights, whether land-based, water-based, propeller, or jet, must go through certain flight phases, as shown here.

Let us deal first with the phases of flight and then the missions.

As shown diagrammatically in Fig. 1, all flights, whether land-based, water-based, propeller, or jet, must go through the following flight phases: (1) take-off, (2) rendezvous (either with an aircraft or a point of departure), (3) navigation, (4) mission, (5), rejoin, (6) return, (7) identification, (8) traffic control, (9) approach, and (10) landing.

With the exception of the mission phase, all others are essentially the same because they are a function of the motion of the c.g. of the aircraft with respect to either a fixed or moving point in space. The actual differences lie in the rates and times involved in the operation.

For example, rendezvous and air interception can be considered identical except that in the former the guns or rockets are not fired and there is no breakaway. Navigation is identical with these except that the total time and rate of closure are different. If this analysis is carried through it will be seen that the remaining phases of flight are in effect a repetition of each other, with only a change of rates and time.

As to missions, these are only variations of other phases of flight. In the case of a transport, the mission is accomplished by conducting the landing phase. A bombing mission is identical to a landing except that the flare-out is made at a higher altitude and is followed by a wave-off. Search is only a specific type of navigation and can also be considered the same as traffic control with variations in the track and numbers of aircraft involved. These statements are not just opinions. Analyze the equations and the similarity will be quite evident.

It can be concluded from such an analysis that

Com. George W. Hoover, USN, Office of Naval Research

Excerpts from paper, "Integration of Aircraft Instrumentation" presented at SAE Golden Anniversary Aeronautic Meeting, Los Angeles, Oct. 14, 1955.

Aircraft Instruments!

any instrument system which is *adequate* for one type of aircraft is then adequate for all other types. Also, if the system is adequate for one phase then it is also adequate, with the proper display, for all other phases.

If we follow this deduction, we find it is necessary to consider the instrument system, not as a separate entity, but rather as an integral part of any aircraft, and incidentally the starting point of any aircraft system.

Who Operates It?

In considering the man-machine combination, there are again two schools of thought. One dictates that the man, being deficient in his ability to cope with complex problems, should be relegated to the menial task of monitoring a completely automatic system utilizing right-left and up-down indicators. The other group believes that man's brain is the finest computer that can ever be created and, if properly utilized, can produce more for less weight than any man-made computer. If a man is going to be in the aircraft, make the best use of him. Recent developments indicate that the latter school is becoming predominant. It is evident that the integration of man and machine can only be accomplished by a properly integrated display and control system. (See Fig. 2.)

How Do We Present the Data?

An aircraft instrument panel has always been made up of many separate instruments each giving a bit of data which, when mentally integrated with the others, yields an answer to the question being asked by the pilot. It is not odd that this method of display was developed because, as a rule, the engineers designing the instruments have been given a specific task to instrument a particular measurement. As the requirements develop, each engineer attempts to supply an answer by providing a measurement of each factor involved rather than a complete answer to the basic problem.

Take the case of the question, "Where am I?"

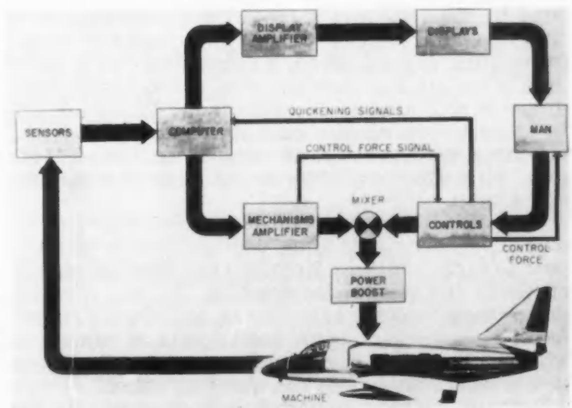


Fig. 2—Schematic diagram showing man-machine system.

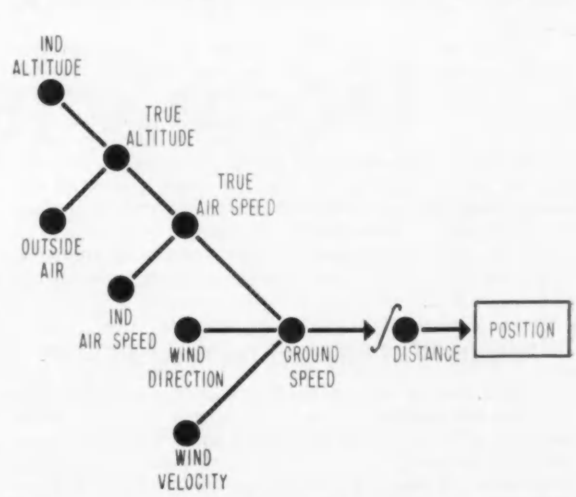


Fig. 3—Present methods of answering the question, "Where am I?" require the use of a whole collection of instruments.

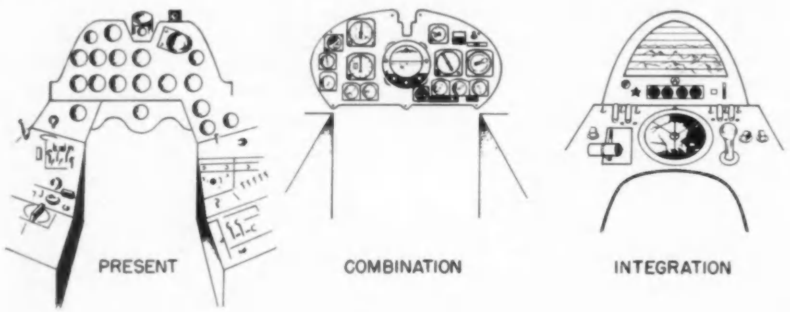


Fig. 4—How a series of items can be integrated as opposed to combining them.

(See Fig. 3.) In the engineer's mind this answer requires the use of an air-speed indicator, which must be corrected for altitude in order to get true air speed. However, the altimeter must be corrected for outside air temperature in order to get true altitude. Then the true air-speed quantity must be inserted into a hand computer with wind direction and velocity to determine ground speed. Integrating ground speed, we find that, for a given time, a certain distance has been covered, and plotting this will answer the question, "Where am I?" In other words, all the pilot needs is an air-speed indicator, an altimeter, an outside air temperature gage, wind direction and velocity, time, a computer, and a map.

With the development of present computer techniques, however, it is quite possible to give the answer to such questions directly, thus eliminating the necessity for mental integration. In other words, rather than indicate each factor, the sensors should feed the values of each factor into a computer, which will provide a signal to a proper display to give a direct answer to the question asked.

Perhaps the most important place for integration is in the display because the human brain aided by the eye does not perceive information piecemeal, but rather in the form of a completely integrated picture.

It may be well to differentiate at this point between integration and simple combination. Integration simplifies whereas combination complicates. Integration leads to the creation of a new and adequite result, while combination is merely compounding a bad situation by attempting to put together what appear to be the best parts of an incomplete design. Combination reduces scanning but integration *eliminates* scanning.

Fig. 4 is an example of how a series of required items can be integrated as opposed to combining the same items.

How Do We Implement the Requirements?

It was stated earlier that one of the outstanding reasons for the lack of adequate instrumentation is because of the emphasis placed on different phases of flight as well as missions, and that each phase has been treated as a problem in itself, by a specialist in that particular field. For instance, in the industry as well as the military, the organization is usually split into divisions with such titles as navigation, armament, powerplant, and landing aids. Each group, being conscientious, considers its role as important, if not more so, than any of the others.

An armament man once stated the only reason for having a military aircraft was to deliver a weapon to a target; therefore, the armament equipment should take precedence over all others. He was probably correct but equally correct are those who work on the take-off, navigation, landing, and the like because, if the pilot can't deliver the aircraft to the theatre of action, he can't very well deliver the weapon to the target. It is also equally important that he get home safely. The only solution for justifying a priority armament system is a Kamikaze, and we cannot tolerate these tactics.

In the final analysis each of the divisions is correct in assuming that its department is the most important but only if properly integrated. The results of the lack of integration are evident in the fact that each system in aircraft today has its own sensors, amplifiers, computers, and displays. When heading is required for a new device, a new sensor is installed, usually because other heading sensors are not adequate to do this particular job. This sensor then requires a different amplifier, and perhaps a different power source. Since the equation to be solved is usually a very specific one, a special computer must be included, and of course a separate instrument for display. Here again, these statements are not opinions. Look in any aircraft today and count the subsystems and then compare them to see the number of elements which are being duplicated.

These statements are not meant in any way to ridicule the engineers who, as a matter of fact, have actually done a magnificent job to keep up with the advancement made in aerodynamics and aircraft development. They are, however, made in order to point out the fallacies of our past methods of conducting research and development which have led us to a state of complexity as well as redundancy.

The solution again is integration of the many subsystems into a reliable, light-weight, universal system: a system with single, amplified sensors, a centralized computer, and an integrated control and display system resulting in a man-machine combination completely adequate and capable of accomplishing any mission, any place, at any time.

For complete paper (in multilith form) on which this abridgment is based, write SAE Special Publications. Price: 35¢ to members, 60¢ to nonmembers.

The President's Message

It has been a wonderful privilege for me to serve SAE as your President during this Golden Anniversary year. I am sure our members have discovered, as I have, that serving our Society in any capacity, brings a flood of blessings not likely to be experienced in other technical organizations. I am most grateful for the opportunities which have been so generously opened to me.

Our engineering fraternity is now over 20,000 strong. It is my firm conviction, after visitations of our activities from coast to coast, that we are strong in striving for high quality in membership—strong in expecting top quality papers—strong in the promotion of quality in meetings.

I sincerely thank the committees, the chairmen, and individual members who have been responsible for fostering the paramount significance of these goals. By forging these links of quality in Sections, Groups, and Student Branches, we are achieving a national chain of superior technical competence.

The Technical Board has again proven its high measure of performance so effectively rendered to the various branches of our automotive industry and to our country. My warm appreciation goes to the chairmen, members, and all those cooperating in the manifold activities of this great technical venture.

I wish to express my special thanks to the Finance Committee members who have overcome unusual problems and who, after facing unexpected emergencies, achieved a strong financial status at the end of this year.

Our technical publications hold a front-line position in the technical world. I am sure I voice for all, great pride in the achievements of those responsible for the publication and distribution of our technical literature.

It is with high esteem that I note the maturing consciousness of our Council in building sound governing policies and broad guiding philosophies as a sagacious bulwark in piloting our Society's activities. In matters which pertain to granting honors, awards, and Section autonomy, such guideposts will prove of exceptional value.

No words of mine can adequately describe the measure of assurance which I have in the soundness of SAE management. This confidence stems from the pervading spirit of helpfulness, the clear wisdom in guidance, and the undergirding hearty support of John A. C. Warner and his loyal staff of co-workers.

1955 Annual Report

SAE's Golden Anniversary year was characterized by special events celebrating the 50th Anniversary in almost every area of the Society's interests. It was marked also by progress both in size and depth throughout the whole range of member activity and achievement.

This 1955 Annual Report is largely devoted to noting and describing the more important of these steps toward a better Society.

Finance Committee Maintains Optimistic Vigilance

As the Society enters its second half century, it is prepared for substantial further progress.

Financially, it has reserves of $943,000 which permit it to budget the use of most of current income for services to members. This year, for example, the budget calls for a black figure of $60,000, which is less than 4% of the predicted income of $1,600,000.

The main body of SAE reserves is invested in securities. The stable backlog consists of U.S. Government Bonds with a value of $461,000. But, for protection against increasing costs, $371,000 has been put in equities. These had a value of $608,000 at the end of our last fiscal year. Furthermore, the Council extended this philosophy recently by approving an increase to 50% as the amount of reserves which may be invested in equities.

As to member services in general, they seem to be fortunately situated if current high level of income from publications can be maintained. However,

J. G. Moxey, Jr.
Chairman
Constitution Committee

A. T. Colwell
Chairman
Finance Committee

H. E. Chesebrough
Chairman
Meetings Committee

W. J. Lee
Chairman
Membership Committee

A. C. Hoffman
Chairman
Placement Committee

advertising revenues play a very important part and are recognized to be highly unpredictable.

Technical Board Program Endorsed

Once again industry has proved generous in its financial support of SAE technical committee work. The Society looks to industry for these funds because the benefits flow primarily to industry, government, and the public rather than to the individual member of SAE.

Because there is a continuing high demand for technical committee work, a further extension of financial support is needed. Therefore, to tell the story to industry more effectively, the Finance Committee has created four Vice-Chairmanships for Technical Funds from Industry. These Vice-Chairmen are leaders in their specialized areas and are developing teams of Group Leaders of high caliber, many of whom have been pulling a strong oar for SAE over the years.

The results of this new alignment are already evident and further progress seems assured.

Sound Financing for Progress

The Finance Committee is keenly aware of the need for a strong financial background and has been moving toward this goal for many years. Further strengthening in keeping with requirements of the moment is its objective, which the Council has never ceased to encourage. The committee's aim is to develop the type of financial competence which will merit the approval of the various operating committees of the Society.

Membership Up; 50-year Certificates Awarded

Highlight of the Golden Anniversary year was authorization of the first certificates in recognition of fifty years of Society membership.

The certificates, bearing greetings from the Council and President Rosen, are being awarded by their local Sections to W. P. Kennedy, J. G. Perrin and Joseph Tracy, who became SAE members in 1905. Also being cited for long-time membership are 75 members receiving certificates in recognition of 35 years of SAE membership, and 112 receiving 25-year certificates.

Steadily growing membership during the year brought the Society's total to a new record high for the sixth consecutive year. Active membership was 20,686 at the close of the fiscal year (September 30), an increase of 6% over the previous fiscal year.

Additions to membership totaled 2395 against losses of 1266. The number of temporarily inactive or reserve members increased from 609 to 659.

The following table shows a breakdown of active membership by grades as of September 30, 1954 and 1955:

	1954	1955
Member	11,271	12,003
Associate	4,858	4,929
Junior	3,428	3,754
Total	19,557	20,686

Membership applications during the year totaled 2402, a drop from last year's all-time record of 2793. Partially responsible for the decrease was a change in the Society's policy for transfer of Enrolled Students to active membership which stepped up the number eligible last year.

2054 Applications Were Graded in 1954-55

The Membership Grading Committee during the past fiscal year reviewed 2054 applications for membership and 363 applications for transfer of grade. It made recommendations on each for the Council's consideration.

It reluctantly recommended against election of 45 applicants, mostly young men whose training and experience did not appear to match the required qualifications for election. Upon the committee's recommendation, Council elected about 40% of the successful applicants to Member grade; 40% to Junior grade and 20% to Associate grade.

During the year the committee recommended and the Council approved revision of forms sent to references requesting information as to the applicants' qualifications for membership. The committee has found that the new forms have brought replies which have been more helpful than the old in determining the applicants' qualifications.

Golden Anniversary Celebrations Highlight National Meetings

Special 50th Anniversary features colored 1955's National Meetings a rich, bright gold—rich in record of achievement, and bright with promise of greater progress still to come. Total attendance marks and just about every meetings record in the book were broken by the eleven Golden Anniversary Meetings held throughout the country.

The celebration started with a bang at the 1955 Golden Anniversary Annual Meeting, the largest SAE gathering ever held. Its technical program featured papers by engineering authorities in the field of each Professional Activity reviewing accomplishment and forecasting future progress. This theme was carried on at the Banquet where SAE's Past President, Dr. C. F. Kettering, spoke on "The Next Fifty Years." Many other Golden Anniversary touches appeared throughout the Meeting week.

A Golden Anniversary Aviation Panel on the future of air transportation featured the program of the Golden Anniversary Aeronautic Meeting held at the Hotel Statler, New York City, in April.

At a Dinner-Dance in celebration of SAE's 50th Birthday, held at the Summer Meeting in Atlantic City, plaques were presented to SAE's forty-three living "Pioneers".

The contribution of the Fall Aeronautic Meeting in Los Angeles was a live TV Show dramatizing aviation progress—past, present and future.

Total registration of 15,800 exceeded the 1954 rec-

M. A. Thorne
Chairman
Public Relations Committee

T. L. Swansen
Chairman
Publication Committee

Leonard Raymond
Chairman
Sections Committee

R. L. Kirkpatrick
Chairman
Student Committee

C. A. Chayne
Chairman
Technical Board

ord by several hundred. Three meetings set new attendance records—the Annual, New York Aeronautic and Summer Meetings. Registration for the GA Transportation Meeting held in St. Louis, and the GA Fuels and Lubricants Meeting in Philadelphia, was exceeded only by that when these two meetings met jointly with the Diesel Engine Meeting in Chicago in 1953. More design engineers than ever before came to the four Production Forums held as part of the Production, Tractor, and New York and Los Angeles Aeronautic Meetings, to exchange information and solve mutual problems with production engineers.

For the third successive year, each of the three Engineering Displays held in conjunction with the Annual, New York and Los Angeles Aeronautic Meetings, set a new high for attendance, number of booths, and income.

An extra attraction of the 1955 schedule was the SAE Automotive Ordnance Day at which more than 1,000 members and guests were introduced to the new Detroit Arsenal in a day of technical sessions and inspection trips.

Section Traditions Crystallize in Guiding Theme

Sections and Groups, during 1955, made this Golden Anniversary year an occasion to review their activities and plan ahead for greater accomplishments. From coast to coast they have participated in celebrating the Society's fiftieth birthday by sponsoring special Golden Anniversary Meetings keynoted by SAE President C. G. A. Rosen or members of his Council.

The Sections Committee Executive Committee crystallized policies and traditions growing out of SAE history into a philosophy for Sections and Groups—a living statement which will guide them in their operations. It states:

> "The objective of SAE Sections and Groups is to generate activities which:
>
> (a) extend the Society's professional benefits to members in their local areas, and
>
> (b) further the Society's objectives as indicated by its Constitution, particularly with respect to maintaining a high level of technical quality and competence.
>
> "Sections and Groups shall be guided by the same principles as the Society itself in the conduct of their affairs."

Steps are underway to revise "SAE Section Procedure" to reflect this philosophy.

Steadily increasing attendance at Section and Group meetings attest to the continually improving technical caliber of programs offered.

Records indicate that more than 50,000 attended these local SAE meetings during the past year and that, of these, 72% were SAE members and 28% guests. Members turned out in greater proportionate strength to support activities of the smaller Sections and Groups, than of the larger Sections. Member attendance at meetings ranged from 9% to 71% of total local membership, with 27% the median.

The Golden Anniversary year saw advancement of the Atlanta and Mohawk-Hudson Groups to Section status. The Society now has 39 Sections and 4 Groups.

Student Branches Grow in Number and Size

Yale University and Southwestern Louisiana Institute were added last year to the growing list of schools at which SAE has Student Branches.

Official SAE student organizations are now active at 53 engineering schools. Informal student clubs at several other schools are working toward recognition as Student Branches. Presently there are 105 colleges which have a goodly representation of SAE Enrolled Students.

On a comparable basis SAE Student Enrollment increased to 4151 from 3800 during the past fiscal year. There were, however, 507 additional Enrolled Students last year who were continuing Student Enrollment for their first year after graduation. There is no like classification for 1955; the extra year of Enrollment having been discontinued by Council action.

Indications for the coming year are that the number of Enrolled Students will continue to increase. There is real enthusiasm shown by the Student Branches. The fine cooperation of Faculty Advisors and Branch Officers with Section and Group Student Committees has resulted in a greater appreciation of SAE Student Enrollment.

Expanded Work Marks Technical Board's 10th Year

At the end of 1955, the SAE Technical Board completed the tenth year of its history.

The Board was set up by the Council at the end of World War II to provide for more effective administration of SAE technical committee operations and to take advantage of experience gained in the Society's war-time operations in this area.

Under the Board's administration, the output of technical committees has gained both in quality and quantity, and SAE standards and recommended practices have earned increasingly widespread acceptance.

Progress in Aeronautical Field

In the aeronautical field in 1955, activity has been maintained at a high level not only in the development of industry standards but also in advisory service on military specifications. Aeronautical

Material Specifications have continued to grow in number, and their use, particularly by manufacturers of aircraft accessories and equipment, has expanded significantly. Progress in the development of specifications for titanium alloys has been particularly notable. Nearly ten million copies of AMS have been distributed since the first one was issued about 15 years ago.

The Engine and Propeller Standard Utility Parts Committee has 90 active projects and during the year completed 29 recommendations for adoption by the military. Detailed recommendations on 165 government specifications and drawings were submitted by SAE committees, particularly on hydraulic, electrical and other accessories and equipment. Work is in progress on oxygen equipment standards for high-altitude operations in tomorrow's jet transports.

It is worthy of mention also that new jet transports introduced during the year all used the SAE cockpit standard as a design guide.

Ground Equipment Work Expands

In the field of ground equipment, much work has been done on standards and recommended practices bearing on the safety of motor vehicles.

The SAE Lighting Inspection Code has been extensively revised and this revision has provided the pattern for a modification of the American Standard Inspection Code. To improve rear lighting on large trucks and combinations, work is in progress on a recommended practice covering wiring on such vehicles. The standard for sockets and plugs has been modified to provide for closer control of filament position in rear signal lamps to obtain more uniform performance from these lamps. Also a new recommended practice has been adopted for transparent plastics used in lamp lenses to obtain longer life and better color stability.

The specification for hydraulic brake fluid has been further revised to take advantage of experience. This specification, incidentally, is being used increasingly by the states as there is a distinct trend toward legal regulation of this fluid.

A new recommended practice has been developed setting up test requirements for motor vehicle seat belt assemblies and a report summarizing cooperative tests for anchorages for such belts has been released.

In the field of heavy construction equipment, standard test codes have been adopted for reserve tractive ability, vehicle drag and hydraulic power pumps. The standards for farm tractor power take-offs have also been revised.

Among other activities are revisions of the storage battery standard to cover 12-volt equipment, instrument grouping on large trucks, terminology for planetary gears, standard for grooved straight pins, revisions in screw thread and spline standards, reports on multi-viscosity oils and on diesel fuels, addition of ten new steels to the hardenability band standard, detail revisions in many non-ferrous metal specifications, new standards for fuel supply connections and for fuel injection tubing, new classification for rigid plastic molding materials, and a new standard for car license plates which will come into universal use in the United States, Canada and other North American jurisdictions.

Publication Changes Aimed at Service Improvement

Changes aimed at improvement were made in almost every publication area last year.

SAE JOURNAL last Fall completed a total revision of its approach to the handling of material from SAE Sections. The new treatment aims to bring readers more useful as well as more interesting news of what Sections are doing. It features an exchange of information aimed at making available good ideas evolved at one Section for use in other Sections.

Twelve special articles looking ahead in engineering in the 12 areas covered by the Society's Activities were the hard technical core of SAE Journal's Golden Anniversary Issue, published in February, 1955. Unusual photographic coverage of the Society's Golden Anniversary Annual Meeting was also a feature of the issue.

In other respects, SAE Journal continued to improve the level of readability of its technical articles throughout the year. Special attention was given to developing reports of National Meetings to bring to non-attendants the technical flavor of the gatherings—and, at the same time, portray the character of the important social and operational aspects.

Total number of editorial pages was 1148 1/3 as compared with 1118 in 1954.

SAE TRANSACTIONS in SAE's Golden Anniversary Year was the largest ever published—816 pages. It included 66 full-length articles—and was in the mail the latter part of September.

Publication in SAE Transactions is the basis for determining the winner of the annually presented Russell S. Springer Award. The award is made each year to the youngest SAE member who is the author of a paper in that year's volume of SAE Transactions. The winner of the second award is J. T. Wentworth (J '54). The paper, which was published in this year's Transactions, is, "Flame Photographs of Light-Load Combustion Point the Way to Reduction of Hydrocarbons in Exhaust Gas", by Wentworth and W. A. Daniel.

SAE HANDBOOK underwent a change in policy, started on a new approach to enhance its usefulness, and participated in the SAE Golden Anniversary celebration in 1955.

The 1955 SAE Handbook contained 19 fewer pages of text than the 1954 edition, despite the addition of 18 new standards and the revision of 68 others. This was made possible by changes in format and better utilization of space. This space-saving program is being continued for the 1956 Handbook to make it a more-convenient-to-use publication.

Council ruled that the Handbook will be made available to members for $1 instead of being made available at no charge to members. The aim is to cut down waste, since the Handbook has become a costly book to publish. The $1 charge will start with the 1956 Handbook.

The 1955 SAE Handbook added to the flavor of the

Society's fiftieth anniversary year by going to a gold-embossed cover instead of the usual silver.

SPECIAL PUBLICATIONS added 17 new titles to its list in 1955. These special publications are all reports growing out of SAE technical committee activity. The list of currently available special publications now totals more than 100. (Special Publications also distributes multilith copies of meetings papers by mail before and after each meeting.)

Total volume of SP sales amounted to $55,891. There were 115,713 pieces of material distributed. Comparable figures for the previous year were $56,231 and 136,320.

Placement Committee Sees Few Problems Ahead

The Placement Committee has followed closely the trends of the times and is gratified to report that high figures for unemployment are not boosted by the members of this Society. The SAE Placement Service continues to enjoy job listings of many times the applicants available. In fact, highly qualified engineers seeking new employment are making up to 60 contacts through the SAE Placement Service.

The Placement Committee's current aim is chiefly to try to help members fit themselves into the right

Treasurer Deals In Financial Facts

During the fiscal year ended September 30, 1955, both Income and Expense topped $1,500,000 and produced Net Unexpended Income of $51,000.

The original budget called for a net of $23,000. Final results of $51,000 were thus $28,000 better than first predicted. Important elements toward this end were Journal Advertising, AMS, and Special Publications which, between them, produced a better-than-budget net of $25,000.

With these results the $51,000 mentioned above carried General Reserves to the all-time high of $943,000. The audited statements follow:

Accountants' Certificate

Society of Automotive Engineers, Inc.:

We have examined the balance sheet of the Society of Automotive Engineers, Inc. as of September 30, 1955 and the related statement of income and expenses, and general reserve, for the year then ended. Our examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the accompanying balance sheet and statement of income and expenses, and general reserve, present fairly the financial position of the Society at September 30, 1955 and the results of its operations for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

New York,
November 18, 1955.

Haskins & Sells

Balance Sheet

at September 30, 1955

ASSETS

Cash—Unrestricted	$ 329,667.50
Restricted	22,986.68
Notes & Accounts Receivable—Less Reserves	15,103.02
U. S. Gov't Bonds	486,310.98x
Preferred and Common Stocks in Investment Advisory a/c	371,471.51x
Accrued Interest on Bonds	3,309.69
Inventories	34,887.53
Furniture and Fixtures—Arbitrary Value	1,000.00
Prepaid Expenses	50,227.65
Total Assets	$1,314,964.56

LIABILITIES AND RESERVES

Accounts Payable	$ 40,308.22
Section Dues Payable	24,949.00
Deferred Credits to Income:	
Member Dues Received in Advance	221,278.85
Income for Technical Board Operations	4,064.80
Journal Subscriptions	8,269.30
Transactions and Handbook	15,836.50
Others	41,923.36
Reserves for Unexpended Memorial Funds	14,927.92
General Reserve	943,406.61
Total Liabilities and Reserves	$1,314,964.56

x Investments carried at cost.

9/30/55 Market Quotation or Redemption Values—U. S. Gov't Bonds	$ 461,516.00
9/30/55 Market Quotation Values—Stocks	608,105.13
	$1,069,621.13

INCOME AND EXPENSE STATEMENT

October 1, 1954 to September 30, 1955

INCOME

Membership		
Dues Earned	$339,993.39	
Subscriptions Earned	112,868.86	
Initiation Fees	33,308.50	
Miscellaneous Membership Income	1,846.10	$ 488,016.85
Publications		
Journal and Transactions Sales	59,900.13	
Journal Advertising—Less Agency Commissions	455,291.00	
Handbook Sales—1954	14,787.80	
Handbook Sales—1955	17,645.00	
Handbook Advertising	18,663.25	
Aeronautical Publications Sales	64,154.43	
Special Publications Sales	55,891.51	
Miscellaneous Publications Income	3,634.72	689,967.84
National Meetings		
Guest Registrations and Papers Sold at Meetings	20,816.49	
11 Dinners	54,790.25	
3 Displays	48,660.00	
Summer Meeting Registrations	10,530.00	134,796.74
Securities		
Interest	12,166.66	
Dividends	14,459.30	
Loss on Sale of Securities	(214.17)	26,411.79
Cash Discounts Earned		1,083.45
Total Member Service Income		1,340,276.67
Income for Technical Board Operations		227,258.64
Total Income		$1,567,535.31

EXPENSES

Sections and Membership		
Direct Expenses		
Sections	$ 15,665.06	
Sections Appropriations & Dues	74,809.35	
Membership and Students	45,269.23	
Miscellaneous Membership Expense	1,417.05	$ 137,160.69
Prorated Administrative Expense (11.4%)		35,346.42
		172,507.11
Western Branch Office		
Direct Expenses		26,559.87
Prorated Administrative Expense (2.2%)		6,821.24
		33,381.11
Carried Forward		$ 205,888.22

Expenses—Brought Forward		$ 205,888.22
Publications		
Direct Expenses		
Journal and Transactions Text	$227,811.39	
Journal Advertising	217,243.13	
Handbook Mailing—1954	1,082.69	
Handbook Text—1955	82,849.40	
Handbook Advertising	7,488.19	
Aeronautical Publications	31,281.35	
Special Publications	40,119.33	
Roster	40,482.57	
Miscellaneous Publications	3,479.36	651,837.41
Prorated Administrative Expense (54%)		167,430.42
		819,267.83
National Meetings		
Direct Expenses		
Department Expense	55,966.28	
Cost of Registrations and Papers	9,797.60	
12 Meetings	60,068.46	
11 Dinners	52,498.90	
3 Displays	14,770.41	
Awards	1,026.01	194,127.66
Prorated Administrative Expense (16.1%)		49,919.07
		244,046.73
Technical Board Operations		
Direct Expenses		
Technical Committees	152,095.21	
CRC Appropriation	33,750.00	
Solicitation Expense	10,874.25	196,719.46
Prorated Administrative Expense (16.3%)		
Technical Share		30,539.18
Members' Share		20,000.00
		247,258.64
Total Direct Expenses	1,206,405.09	
Total Prorated Administrative Expenses	310,056.33	
Total Expenses		1,516,461.42
Excess of Income over Expenses		51,073.89
General Reserve at Beginning of Year		892,332.72
General Reserve at End of Year		$ 943,406.61

B. B. Bachman

Treasurer

job. The committee sees the present, not as a time merely to get a job or make a switch, but as an opportunity to get settled in the RIGHT job. It hopes to help point the way to further progress toward this goal.

Public Relations Utilizes New Media

In SAE's Golden Anniversary Year opportunity was taken to develop much special, institutional publicity appropriate to the celebration of the Society's 50th birthday.

In addition to the regular program of publicizing members and technical papers, general feature stories about the SAE appeared in Highway Highlights, Canadian Motorist, Old Timers News, many company house organs, and other publications.

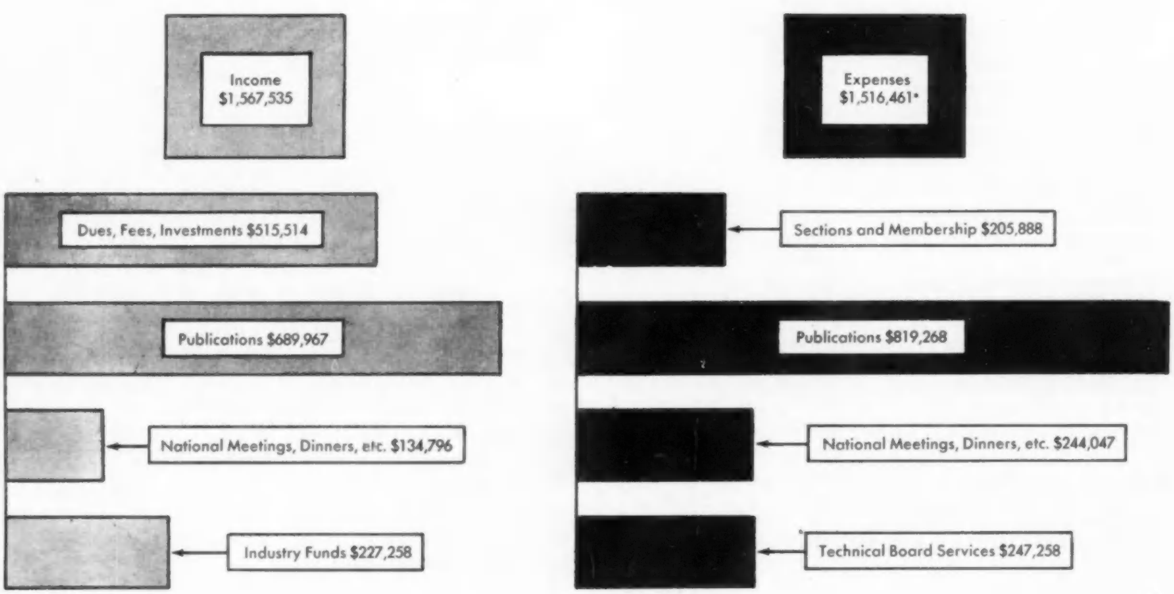
At the 1955 Annual Meeting; the anniversary was heralded by radio and television broadcasts. During the Aeronautic Meeting in Los Angeles, SAE's story was told on a half-hour TV show. A kinescope of this program has been obtained and is available for use by Sections.

1955 also saw an increase in the cooperation between SAE and other Societies for mutual public relations benefit. The first Nuclear Engineering and Science Congress received and gave SAE publicity. Automobile Old Timers awarded SAE a citation and publicized it in trade papers and Old Timers News. The Institution of Mechanical Engineers presented a scroll to mark the Society's 50th Anniversary.

The number of newspaper reporters covering SAE meetings has increased considerably, giving evidence of improved press relations and increased trade and public interest in SAE.

The Society is continuing its policy of directing its public relations program primarily to top management and engineers in the automotive industry, SAE members, students, and the general public, in that order. The program continues to be carried out chiefly by volunteer members, advised and assisted by the SAE staff.

Where SAE Funds Came from . . . and How They Were Spent



*Includes administrative expenses of $310,056 prorated among the four expense classifications.

SECTIONS

JANUARY 1956

Archives Provide a Rear-View Mirror for Sections

Murray Fahnestock, archivist for Pittsburgh Section, asks: "Has your Section an archivist? Are you steering your Section by watching the wake?

Pittsburgh Section is. Here's why, and how."

Objectives

(a) To assist the future to avoid some of the mistakes of the past.

(b) To provide factual data—in usable form—for the assistance of new committee chairmen and Section officers.

(c) To function as a permanent secretary—without expense.

The question has been rightly raised "Why should such a forward looking group as the Pittsburgh Section ever bother to look backward? Haven't the Detroit and Metropolitan Sections done very well—without an archivist?"

Both the Detroit and Met Sections have paid employees, who have reliable records and who can furnish adequate information as to previous Section activities. These employees function as "archivists" without the title, but with wages instead.

That's all right—for the biggest Sections. But permanent employees may be too much of a financial drain on the average SAE Section. That's a matter for each individual Section to decide, as to whether the cost of employees and office space, would be better spent on other Section activities.

Younger Sections may not feel the need for Archives now, but why not consider Archives as "insurance for maturity" as the Section grows older and as the enthusiasms of the charter members start to wane?

Our Pittsburgh Section tried the permanent employee plan and found it a financial burden too grievous to be borne during the depression years. Besides, we find that having the volunteers stimulates their interest in the SAE. It also prevents the election of officers who never did anything before they were elected and proved a flop after they were elected. When we work for a Section—it becomes our Section.

There is some sense in the wisecrack, "Don't file it—throw it away."

There is also some sense in, "Keep carbon copies of all correspondence—you don't know when you may need it!"

The ancient Greeks said, "Nothing to excess."

So, in order to achieve a happy medium (the Archives) between the "cupboard of Old Mother Hubbard" and a rubbish attic, we arrive at the hour of decision for "long-range planning." Very difficult and very necessary. . . .

Long-range planning for Section management is the basic idea of the Archives.

The problem . . . to save *only* records which may be of future use.

CONTINUED ON PAGE 107

MONTREAL

A. A. Larkin, Field Editor

THE SECTION GOVERNING BOARD now meets twice a month. In addition to the usual meeting just prior to the Section monthly dinner meeting, they now hold interim meetings at members' homes.

The added home meetings allow ample time for thorough discussion of Section business and have developed an increased spirit of co-operation and fellowship among Board members.

Central Illinois

Harlan Banister, Field Editor

Section Health Diagnosed, Treated, Cured

A healthy Section has to be a growing and a working Section. Central Illinois leaders have put this thesis to work in the Earthmoving Industry Conference. And they have proved it true.

Between 1948 and 1950, Central Illinois governing boards discussed various methods to stimulate interest in the local membership.

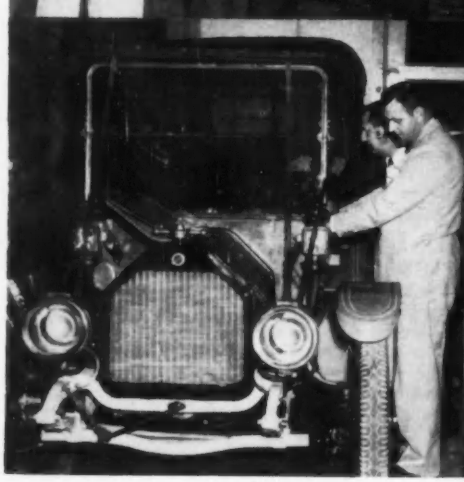
The primary interests in the Central Illinois Section have been diesel engines and heavy earthmoving equipment. During 1948–1950 the automotive type of earthmoving equipment was comparatively new. It had received little publicity except for its use in the armed services during World War II. Although technical meetings in the past had been centered on the activities of most engineering fields, there was no technical meeting designed to serve the interests of the earthmoving industry.

Preliminary discussions led to the conception of an Earthmoving Industry Conference. The conference was to be sponsored and operated by the Central Illinois Section, but was designed to serve the needs of all people and activities connected in any way with the earthmoving industry.

The First Annual Earthmoving Industry Conference was held in April, 1950, in Peoria, Illinois. Five hundred and ninety-six people registered during the two-day program which discussed the earthmoving industry, its aims, its problems, and its successes.

The Committee for the first conference in 1950, set down the following

From Section Cameras



list of objectives.

1. To publicize the high order of engineering activity in the development of earthmoving machinery.
2. To arouse the interest of engineers and induce them to enter the earthmoving industry.
3. To serve the engineers engaged in designing and developing earthmoving equipment by enlarging their knowledge of the field.
4. To bring to local engineers, and especially to younger engineers, a meeting of national significance.
5. To interest young engineers in the area to become associated with SAE or one of the other engineering technical societies.
6. To promote the general welfare of the earthmoving industry and of the community.

The Earthmoving Industry Conferences have been held each year since 1950. Their success can be judged by many things:

A plateau was reached in the Central

1. A feature event of the Canadian Section November meeting was the presentation of SAE Membership Certificates. Ten members of the Section were honored. **Warren B. Hastings** (second from the left) was awarded a 35-year Certificate. Members receiving 25-year Certificates included (left to right): **Josef K. Chmel, Horace Harpham, Albert Olson,** and **Arthur Frazer.** (See story on page 104.)

2. **35-Year Member Warren B. Hastings** appears with four other Canadian Section members receiving 25-year Certificates. Shown are (left to right): **R. W. Richards, James C. Armer, Gordon McIntyre, W. B. Hastings** and **Norman H. Daniel.** (See story on page 104.)

3. An antique auto show was a highlight of Texas Gulf Coast Section South Texas Division Nov. 28 meeting. One of the autos provided by the Horseless Carriage Club of Texas is inspected by Division members.

4. Donald Graham was guest speaker at Western Michigan Section's Nov. 8 meeting. Graham is chief application engineer, Sales Development Department, Euclid Division, GMC.

Illinois membership campaign from 1948 to 1950. The existence of a similar plateau for national SAE membership may or may not be coincidental The First Earthmoving Industry Conference was held in 1950, so that year has been taken as a base year for all three factors. In five years, the registration at the Earthmoving Industry Conference has about doubled. During the same five years, the membership in the Central Illinois Section has tripled. Central Illinois is one of the leaders in membership increases, and the Earthmoving Industry Conference has become the fourth largest SAE technical meeting. It is exceeded only by the Annual Meeting, the Summer Meeting, and the National Aeronautical Meeting, all managed by the national Society.

This comparison is not cited to show the success of an individual undertaking, but it shows that a growing organization and a good man-size job go hand-in-hand.

The Earthmoving Industry Conference is operated entirely by members of the Central Illinois Section. A general committee formulates the overall plans. An arrangements committee deals with local hotels for meeting places and banquet space; a housing committee makes advance plans to accommodate the larger number of delegates and out-of-town visitors. A program committee plans meetings to cover material of current interest. Other local members handle publicity, reporting, and the other jobs connected with the meeting.

The conference has had its difficulties and growing pains. At one meeting, the banquet speaker failed to appear and the national SAE President and a Staff representative were called to fill the gap. Housing and space for the meetings and the banquet have been taxed heavily by the large attendance. These problems are now being tackled by the 1956 Committee.

The size of the project has led to the preparation of annual E.I.C. histories, which aid subsequent committees by spelling out in detail the procedures and duties involved in conducting the conference.

Sure, it's a lot of work—but the rewards gained from SAE affiliation (or from any association) are limited only

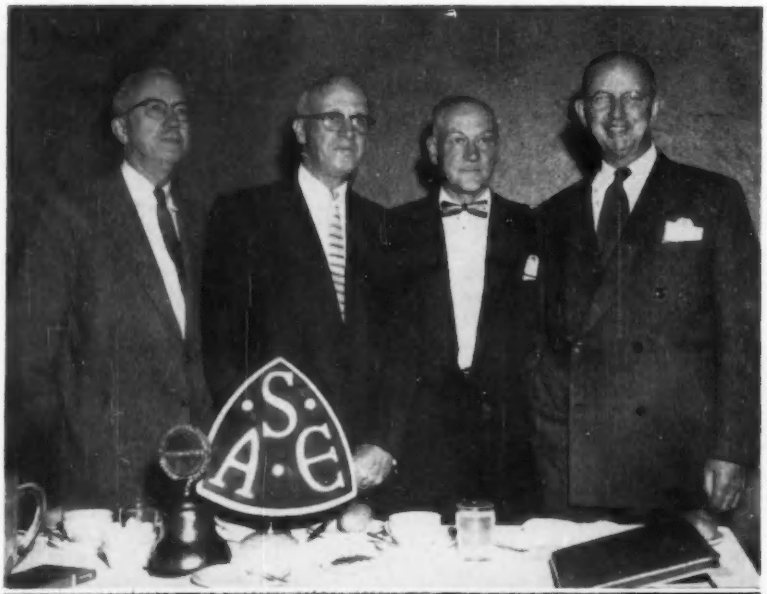
1. **W. G. Brown,** (center) shown here at work during a Section planning board meeting, is SAE Northern California Section chairman. SAE Journal erred in giving the title of his office in a caption on page 89 of the November issue. Division chairmen serving under Brown are: R. A. Hundley of the Section's South Bay Division; and V. C. Ryland of Sacramento Division.

Busy with Brown are **Elvin B. Lien** (left), Northern California Section vice-chairman; and **W. E. Winterbourne** (right), Northern California Section secretary.

2. The Aviation meeting of Northern California Section on Nov. 16 featured guest speaker **H. M. Mulder** (left), Allison Division, GMC. Shown with him (left to right) are **Paul Campbell**, Section vice-chairman (Aeronautics); **R. G. Hall**, regional director, GMC; **Peter Burger**, United Air-lines, Inc., coffee speaker; and Northern California Section chairman **Warren G. Brown.**

3. Speaker for the Atlanta Section Nov. 7 meeting was **Jesse W. Richards,** Continental Division, Ford Motor Co. His subject was the Ford "Continental."

4. **Elmer Sanborn,** National Carbon Division of Union Carbide & Carbon Corp., receives an SAE 25-year Membership Certificate from **Ernest D. Troutman** (right), Auto Electric Co. of Georgia. The presentation was made at the Atlanta Section Nov. 7 meeting. Sanborn is Atlanta Section chairman, while Troutman is Atlanta Section vice-chairman.



by the effort invested. We in the Central Illinois Section recommend that if you want your Section or Group to grow, get a good hard project for it to work on. The results will amaze you.

COMMITTEE WORK is getting a real boost at Central Illinois. There are 23 members serving on national technical committees. An additional 9 are working on national Activities committees. That represents almost 10 percent of the Section membership.

ST. LOUIS

F. H. Roever, Field Editor

Local Section Does National Meeting Honors

Local contribution to the total success of the national meeting is an important element in Society operation.

Since most SAE national meetings are held in cities where automotive engineering activity exists, there is usually a local Section that assumes the role of host.

During the meeting, the Section participates actively and contributes to

1. Official visit of **SAE President C. G. A. Rosen** was made to the British Columbia Section on Nov. 28. Pictured with **Dr. Rosen** (center left) are (left to right) **Burdette Trout**, Section secretary; **L. B. McPherson**, Section chairman; and **J. B. Mortimer**, Section immediate past-chairman.

2. **Col. G. T. Peterson** (right) was the honored guest of these Central Illinois Section dignitaries at the Nov. 28 meeting. Shown with him are **R. V. Larson** (left), Section chairman; and **G. E. Burks** (center), technical chairman.

3. This speakers' table gathering was caught by the camera at the Mid-Michigan Section Nov. 14 meeting. Included are (left to right) **Karl Schwartzwalder**, Section Program Committee member; **Hugh Jacox**, speaker, Capital Airlines, Inc.; **Dr. Louis Otto**, Section chairman; **Bruce Thompson**, speaker, Capital Airlines, Inc.; **Philip Zeigler**, Section treasurer; and **Miles G. Hanson**, receiver of an SAE 35-year Membership Certificate.

the success of the meeting in terms of smooth operation and extra-curricular quality. The St. Louis Section has just played this part in the Golden Anniversary Transportation and Diesel Engine Meetings.

While the two overlapping meetings were held from Oct. 31 through Nov. 4, Section preparations began at the Annual Meeting in Detroit last January. At that time local member Monroe Alves was selected as General Chairman of the Transportation Meeting. He met with Robert Gardner, Vice-President of Transportation and Maintenance Activity. At the same time two other local members, Lee Wendt and Gus Blattner, were meeting respectively with F. A. Robbins, Diesel Engine Activity Vice-President, and R. C. Norrie, Truck and Bus Activity Vice-President. Wendt was chosen as General Chairman for the Diesel Engine Meeting. While these planning meetings were going on in Detroit, the participating Activity Committee members were busy setting up the technical content of the programs. Once determined, these provided the St. Louis Section with a basis for promoting the meeting locally and for extending its benefits into a profitable and pleasant experience for every person in attendance. The local Section assumed responsibility for entertainment, hospitality, and local publicity.

Regardless of function, the work load divided itself into two parts—that which must be done ahead of the meeting and that which must be done during the meeting. For instance, under entertainment pre-meeting work came arranging for the tours of the St. Louis Public Service Co. shops, obtaining a banquet toastmaster, obtaining a prominent and inspiring banquet speaker, and raising funds for a Section sponsored social period. Hospitality efforts included selecting and inviting, via the SAE New York office, all the guests occupying seats at the head table. Local publicity required contact with many of the area companies and institutions, from which local attendance was desirable. This included management contacts about special arrangements for attendance of younger men not normally free to leave their work during the day.

During the meeting the entertainment and hospitality committees welcomed the registrants as they arrived, extended tour invitations to them, served as hosts at social functions, and held a small pre-banquet reception for those sitting at the head table. The hospitality committee was responsible for the banquet speaker during his entire stay in St. Louis. At the pre-banquet reception the speaker met each person selected to sit at the head table. At banquet time the head table guests were arranged in a pre-determined sequence and proceeded to the banquet for a smooth seating and orderly banquet opening.

During the five days of technical sessions, contact with the local newspapers was kept alive, resulting in a favorable reporting situation for the entire meeting.

Between January and October, local committee meetings and local governing board meetings were required. There was some sweat and a few moments of worry, but this was

From Student Cameras

1. A successful membership campaign in action at the University of Miami shows **Faculty Adviser John D. Gill** welcoming new member **Harvey Olin.**

2. Officers of the University of Miami Student Branch sign up a new member. Around the table (left to right) are: **Henry Bach,** secretary; **Dick Partin,** chairman; **Stewart Archer,** vice-chairman; **Phil Peterson,** treasurer; and a new member.

3. Chairman **W. E. Schulz** of the Chrysler Institute of Engineering Student Branch welcomes R. C. Haeusler to the speaker's table. Haeusler, of Chrysler Corp., was honored guest at the Branch Nov. 9 meeting.

4. General Motors Institute Student Branch listened to a very interesting talk by **Thomas M. Fisher** at the Nov. 17 meeting. As assistant head of technical data at the GMC Proving Grounds, Fisher spoke on product testing and testing facilities at the Proving Grounds.

far outweighed by the satisfaction of having contributed to a very successful national meeting. Section members Clifford Feiler, Monroe Alves, Lee Wendt, Gus Blattner, Al Hazell, Orval Lindell, and George Vahrenhold contributed heavily of their time and talents. We of the St. Louis Section are inspired by the job they did.

BUFFALO

Dudley Losee, Field Editor

Crux of Meeting Success In 'Meetings & Arrangements'

The final success of any Buffalo Section meeting lies in the planning and work of the Meetings and Arrangements Committee. As the name implies, this committee is responsible for obtaining adequate meeting and speaker accommodations.

To provide these required accommodations, it is necessary to prepare and send out meeting notices and maintain a dinner reservations list. The committee must handle all last minute details concerning the number of dinners required, seating arrangement at the Speaker's Table, and conversion of the dining room to a meeting hall.

The activities of this committee are too numerous for one or two people to handle. They must be shared in order to insure the success of Section meetings.

Help is required in making the speaker comfortable. Members must arrange for his transportation, hotel accommodations, and introductions. They must try to anticipate his needs throughout his contact with the Section.

A speaker's needs may include props at the meeting. He may want display tables, a loud speaker system, or projection equipment.

Only through combined effort can this committee operate effectively. Buffalo Section is proud of its committee's success.

No. California

L. J. Abell, Field Editor

SIXTY MEMBERS AND GUESTS, including several sons of members, visited the NACA's Ames Laboratory on a field trip of the Northern California Section of SAE Nov. 16. They saw

CONTINUED ON PAGE 96

Section

ALBERTA

January 20 . . . Al San Club

ATLANTA

February 6 . . . **Darrel C. Romick,** Guided Missiles Department, Goodyear Aircraft Corp., Akron, Ohio.—"Space Travel." Briarcliff Hotel. Dinner 7:00 p.m. Meeting 8:15 p.m.

BRITISH COLUMBIA

January 16 . . . Joint Meeting with Canadian Aeronautical Institute.

February 13 . . . SAE Student-Section Meeting. University of British Columbia.

BUFFALO

January 17 . . . Speaker from Oldsmobile Division of General Motors Corp. "Automatic Transmissions for Passenger Cars." Hotel Sheraton. Dinner 7:00 p.m. Meeting 8:00 p.m.

CANADIAN

January 18 . . . Film—"Engineering Safety." Through courtesy of Ford Motor Co. Royal York Hotel. Meeting 7:00 p.m.

CENTRAL ILLINOIS

January 30 . . . **F. R. Holiday,** Chrysler Corp.—"Design of Die Cast Torque Converter Housings." Pere Marquette Hotel. Dinner 6:30 p.m. Meeting 7:45 p.m. After-Dinner Speaker: Bob Von Atta, basketball coach, Bradley University.

CHICAGO—South Bend Division

January 30 . . . **Melvin C. Bartz,** senior project engineer, Electronics Section, Bendix Products Division, Bendix Aviation Corp., South Bend, Ind.—"Telemetering—The Tool of Modern Industry." LaSalle Hotel (Bronzewood Room) South Bend, Ind. Dinner 6:45 p.m. Meeting 8:00 p.m.

February 14 . . . **William E. Swenson,** chief engineer, Minneapolis-Moline Co., Minneapolis, Minn.—"Technological Advances in Relation Between Farm Tractors and Implements." Hotel Knickerbocker, Chicago. Dinner 6:45 p.m. Meeting 8:00 p.m. Special Features: Social Half-Hour before dinner (6:15 p.m. to 6:45 p.m.) sponsored jointly by Federal-Mogul Corp. and Rockford Clutch Division, Borg-Warner Corp.

CLEVELAND

January 16 . . . **Richard H. Albrecht,** group engineer, staff assistant, Automotive Laboratory, Standard Oil Co. of Ohio, Cleveland.—"Stop Sludge & Go Clean." Hollenden Hotel. Dinner 6:30 p.m. Meeting 7:45 p.m. Special Features: There will be a formal discussion following presentation of paper.

COLORADO

January 19 . . . Speakers from Gates Rubber Co., Denver, Colo. —**Kenneth G. Custer,** assistant technical director; **Lee Mitchell,** manager, Tire Development; **Charles Moore,** tire research engineer.—"New Developments in Truck Tires." Gates Rubber Co. Meeting 7:30 p.m.

INDIANA

February 16 . . . "Atomic Power Reactors."

METROPOLITAN

January 25 . . . **Colonel John Paul Stapp,** USAF.—"The Fastest Man on Earth. How?? Why??" The Brass Rail Restaurant, Fifth Avenue & 43rd Street, New York. Cocktail Hour 5:30 p.m. Dinner 6:30 p.m. Meeting 7:45 p.m.

February 8 . . . Activity Meeting. Plant Tour—Fort Motor Co., Mahwah Plant, Mahwah, N. J. (Met Section Accelerator will announce details).

Meetings

MID-MICHIGAN

February 6 . . . **A. L. Haynes**, assistant chief research engineer, Ford Motor Co., Dearborn, Mich. **John L. Moore**, Cornell University Medical College.—"Safety Consideration in Automotive Design." Oldsmobile Auditorium—Lansing. Dinner 6:30 p.m. Meeting 7:30 p.m.

MILWAUKEE

February 3 . . . **N. J. Bifano**, Aircraft Nuclear Propulsion Department, General Electric Co., Cincinnati, Ohio.—"The Application of Nuclear Power in the Transportation Field." Milwaukee Athletic Club. Dinner 6:00 p.m. Meeting 8:00 p.m.

MOHAWK-HUDSON

February 8 . . . "High Speed Engines for Commercial Vehicles."

MONTREAL

January 12 . . . Students' Night. Two Papers to be presented. Student from McGill University and Student from University of Montreal. Mount Royal Hotel. Dinner 6:30 p.m. Meeting 8:00 p.m. Special Features: 20 minute talk on "Engineering Education." J. T. Dyment, Trans-Canada Air Lines.

NEW ENGLAND

February 7 . . . Passenger Car Meeting

NORTHERN CALIFORNIA

January 25 . . . **I. T. Rosenlund**, chief, automotive technical service, E. I. Du Pont de Nemours & Co., Wilmington, Del.—"Fuel Injection for Passenger Car Engines." Engineers Club, San Francisco. Dinner 6:30 p.m. Meeting 8:00 p.m. Special Features: Lincoln Test Car Equipped with American-Bosh Injection Equipment.

NORTHERN CALIFORNIA
South Bay Division

February 7

NORTHWEST

February 3 . . . **H. M. Place**, U. S. Rubber Co.—"Tubeless Tires." New Yorker Cafe, Tacoma, Wash. Dinner 7:00 p.m.

ST. LOUIS

January 16 . . . Fuels & Lubricants Activity Meeting. **John A. Edgar**, Shell Oil Co., Calif.—"Role of Additives in Lubrications." Gatesworth Hotel. Dinner 7:00 p.m. Meeting 7:45 p.m.

February 2 . . . **J. S. Miller**, Monsanto Chemical Co.—"Plastics that are Interesting to the Automotive Industry."

SAN DIEGO

February 7

SOUTHERN CALIFORNIA

January 16 . . . Aircraft Dinner Meeting

January 23 . . . Aircraft Production Panel Meeting. **K. H. Boucher**, chief tool engineer, Douglas Aircraft Co., Santa Monica; **A. E. Whatley**, manager, Planning Department, Lockheed Aircraft Corp.; **Julius Kany**, supervisor, Tool Design, North American Aviation, Inc.; and **Melvin Dunbar**, Northrop Aircraft, Inc.—"Interchangeability of Component Parts." Ethyl Auditorium, Los Angeles. Meeting 7:30 p.m.

February 6 . . . Automotive Panel Meeting

SOUTHERN NEW ENGLAND

January 17 . . . 20th Anniversary Meeting. **Willy Ley**, noted authority on Rockets, Satellite Stations & Space Travel, to be speaker. Bradley Field.

SPOKANE-INTERMOUNTAIN

January 18 . . . Caravan Inn. Dinner 7:00 p.m. Meeting 8:00 p.m.

TEXAS

February 10 . . . Aircraft Meeting

TEXAS GULF COAST

January 13 . . . **E. C. Paige**, manager, Commercial Engines & Fleet Section, Ethyl Corp., Detroit.—"Distributor Advance Curves and their Affect on Performance and Economy." College Inn, Houston, Texas. Dinner 6:30 p.m. Meeting 7:30 p.m.

February 10 . . . Production Activity Meeting

TWIN CITY

January 18 . . . **R. J. Mandle**, assistant project engineer, Shaft Turbines & Ducted Fans, Continental Aviation & Engineering Corp., Detroit.—"Small Gas Turbines." Curtis Hotel, Minneapolis. Dinner 7:00 p.m. Meeting 8:00 p.m.

February 8 . . . Field Trip through Minneapolis - Moline's new Engineering Building.

WESTERN MICHIGAN

February 7 . . . **Carl Bachle**, vice-president, Continental Aviation & Engineering Corp., Detroit.—"Turbine Engines." Doo Drop Inn, Muskegon, Mich. Dinner 7:00 p.m. Meeting 8:00 p.m.

WILLIAMSPORT

February 6 . . . **Tench Francis**, N. Y. sales manager, Sun Electric Corp., Chicago, Ill.—"Engine Test Equipment." Moose Club. Dinner 6:45. Meeting 7:45 p.m. Special Features: Color sound film on Latest Sun Equipment.

Recent Rapid Growth in SAE Standards Presages Active Future

THE growth of SAE standardization work in the last decade or so provides a pretty solid basis for confidence in the future of standardization in the automotive industries, Don Blanchard, secretary of SAE's Technical Board, told a recent national convention of the Standards Engineers Society, in Hartford.

He pointed out that SAE has been active in standardization for over 45 years. Illustrative of the immense growth: the first SAE Handbook appeared in 1914 with 50 pages; the 1955 edition has 1094 pages. Similarly, starting almost from scratch in 1940, there has been a rapid expansion in SAE aeronautical standards.

Blanchard said that SAE's series of Aeronautical Material Specifications, which now number 675, are being used increasingly by the manufacturers of air frames and accessory equipment as well as the engine and propeller manufacturers for whom the development of this series of standards was originally undertaken. Incidentally, SAE has distributed more than 10,000,000 copies of AMS.

Although the automotive industries recognize the advantages of standardization, they may be expected to continue as they have in the past to use standards, or not use them, depending on the circumstances surrounding the particular application.

Under the present conditions of intense competition in the automobile industry, the pressure is really on for economy. Hence, variations not justified by over-all economics are the subject of increasingly close scrutiny. However, it should be realized that situations arise where the balance turns in favor of a nonstandard product or practice. With big volume, the nonstandard item may cost no more, and with large national dealer organizations, automobile companies can give a nonstandard part as good, and perhaps better, distribution than a standard item. Hence, if a nonstandard item offers corrolary advantages, it will be the choice.

Standards developed for the use of regulatory agencies will continue to be of basic importance to both industry and government. The SAE Lighting Standards are good examples of this type. Every motor vehicle in service in the United States today is equipped with lamps built to these standards. These standards are of the performance variety. In the case of headlamps, dimensional standards also have been adopted so that the standard Sealed Beam unit fits any vehicle manufactured since 1939.

There is a slow but steady tendency for the number of items subject to this type of regulation to increase. In some states brake hose must be of an approved type and there is quite a trend currently to regulate hydraulic fluids. SAE standards are used for this purpose as well as for the regulation of a few other items.

The Society gives a somewhat similar service to the air transport industry on instrument standards. These standards are referenced in the Technical Service Orders of the Civil Aeronautics Authority.

In the aircraft field particularly, advising the government on its standards and specifications is expected to continue to be an important element in SAE standards works.

Besides standardization within the automotive industry, inter-industry standardization, through the ASTM, ASA, and AISI, will continue. At present SAE is sponsor of five ASA sectional committees, and participates in more than 30 sectional committees. It also participates in the work of 14 ASTM committees.

The work of SAE's nonferrous metals and nonmetallic materials committees is closely correlated with appropriate ASTM committees. We also work closely with the AISI on steel standards. This sort of inter-industry cooperation has been most beneficial to everyone and will probably continue indefinitely.

1956 SAE National Meetings . . .

January 9-13
Annual Meeting
The Sheraton-Cadillac Hotel and Hotel Statler, Detroit, Mich.

March 6-8
Passenger Car, Body, and Materials Meeting
Hotel Statler
Detroit, Mich.

March 19-21
Production Meeting and Forum
Hotel Statler, Cleveland, Ohio

April 9-12
Aeronautic Meeting, Aeronautic Production Forum, and Aircraft Engineering Display
Hotel Statler, New York, N. Y.

June 3-8
Summer Meeting
Chalfonte-Haddon Hall
Atlantic City, N. J.

August 6-8
West Coast Meeting
Mark Hopkins Hotel, San Francisco, Calif.

September 10-13
Tractor Meeting and Production Forum
Hotel Schroeder, Milwaukee, Wis.

October 2-6
Aeronautic Meeting, Aircraft Production Forum, and Aircraft Engineering Display
Hotel Statler, Los Angeles, Calif.

November 1-2
Diesel Engine
The Drake, Chicago, Ill.

November 8-9
Fuels and Lubricants Meeting
The Mayo, Tulsa, Okla.

About SAE Members


Bergen


Grooss


Hosterman


Gerwig


Ashburn


Rasmussen


Douglas


Hanneman

ANDERSON ASHBURN has been promoted to managing editor of **American Machinist.** Before that he was special products editor of the magazine and has been with McGraw-Hill for the last 14 years.

Ashburn is currently a member of the SAE Production Activity Committee and the Student vice-chairman of SAE Metropolitan Section. He is also working on the Program Committee developing the SAE 1956 National Aeronautic Meeting in New York.

CARL A. RASMUSSEN is now assistant chief engineer for Cadillac Motor Car Division, GMC. He has been serving in the position of special assistant to the chief engineer since 1952. He joined Cadillac in 1940 as a laboratory technician.

EARL M. DOUGLAS has been named vice-president of Dana Corp. with responsibility over technical activities relating to product engineering. His duties will include personal supervision of the corporation's special products, as well as its day-to-day engineering activities.

Douglas served previously as vice-president-manufacturing for Studebaker-Packard Corp. There he headed the defense manufacturing division.

WALTER M. HANNEMAN has been honored for 25 years of service with the Shakeproof Division of Illinois Tool Works. He is serving as executive engineer with offices in the company's Elgin, Illinois plant.

LT. GEN. JAMES H. DOOLITTLE, vice-president and director of Shell Oil Co., N. Y., said that the destructive power of our air force has been increased more than a million times. He spoke at the diamond jubilee annual meeting of ASME.

"Commercial aviation traditionally follows the lead of the military. Thus, as military planes begin to face the thermal barrier . . . the commercial planes are approaching the so-called sound barrier, getting up toward 600 mph. They are also improving steadily in safety, in reliability, and in comfort," said Doolittle. His talk was delivered in a panel on "The Economic Aspects of Technology."

FRED W. KELSEY has been appointed quality manager, Dodge Truck Plant, Dodge Division, Chrysler Corp. Since 1952 he has been on the executive staff at the Dodge Truck Plant doing special assignment work in manufacturing, sales, service, and quality control.

CARL E. BERGEN is now an advance design cost engineer for Chrysler Corp. Highland Park Engineering. He was a senior cost engineer with Ford Motor Co.

In his new position he has been assigned unit supervision duties in the newly created Engineering Analysis and Process Development Department. His duties will be connected chiefly with advance vehicles producing a design cost for engineering guidance.

FRANK A. GROOSS has been appointed to a new position for Caterpillar Tractor Co. He will serve as assistant to vice-president **G. E. BURKS**, who has administrative responsibility for the Engineering and Research departments. He has been assistant chief engineer at the new Caterpillar plant in Decatur, Ill.

A. W. SIEVING, formerly general supervisor of Decatur Engineering, has succeeded Grooss as assistant chief engineer.

FRED O. HOSTERMAN has been appointed vice-president in charge of sales for Weston Hydraulics, Ltd., a subsidiary of Borg-Warner Corp. He was chief sales engineer.

HARVEY F. GERWIG, formerly chief design engineer for Weston Hydraulics, has been appointed vice-president in charge of engineering.

ALFRED L. BOEGEHOLD received an **Iron Age** salute on page 97 of the magazine's Nov. 10 issue. He was honored for his achievements in the field of automotive metallurgy.

"His 30-year record of auto metallurgy shows a knack of coming up with the right answer," states Iron Age.

Boegehold was 1954 SAE Vice-president representing Engineering Materials Activity. He is also past-president of the American Society for Metals, receiving ASM's 1955 Gold Medal for "great versatility in applying science to the metal industry."

NICHOLAS P. OGLESBY has been appointed chief of the Construction Equipment Section at the Corps of Engineers' Research and Development Laboratories, Fort Belvoir, Va. He has been serving as a project engineer at the Laboratories.

RICHARD H. DEMOTT has retired as president of SKF Industries, Inc. He will continue his 40-year career with the company as chairman of the board. He first started with the firm as sales apprentice.

EDWIN R. BRODEN, who has been serving as executive vice-president of the company, succeeds DeMott as president and chief executive officer. Broden joined SKF in 1955 as executive vice-president.


Rockwell


Hayden


Burgie


Bennett


Shurts


McRoberts


Howard


Stout

WILBUR F. SHURTS has been elected vice-president—Engineering for the Twin Disc Clutch Co. He joined Twin Disc in 1940. He has been director of engineering since 1951.

R. C. McROBERTS has been named industry manager—Engine Accounts for Twin Disc Clutch Co., Racine, Wis. He has been assistant sales manager of the Hydraulic Division.

GEORGE BASTIAN has been named industry manager—Metal-Working Accounts. He has been a district sales manager for the company.

IVAN E. HOWARD has been appointed district manager of the Cleveland District office of Lamson Mobilift Corp., Portland, Ore. He will be in charge of sales and service of the complete line of stand-up and sit-down models of fork trucks in western New York, western Pennsylvania, Ohio, Kentucky, West Virginia, and Michigan.

Howard has been general service manager for Clark Equipment Co., Industrial Truck Division since 1951.

ERNEST G. STOUT is now associated with The Ralph M. Parsons Co. of Los Angeles as assistant manager of business development. He has been a staff engineer for Convair Division, General Dynamics Corp. For his developments with Convair he received the Lawrence Sperry Award in 1941 and the Sylvanus Reed Award in 1953 from the Institute of the Aeronautical Sciences.

GORDON W. MACKINNEY has been promoted to assistant to the general manager, Propeller Division, Curtiss-Wright Corp., Caldwell, N. J. He had been manager of the contract and order department.

EDWARD A. BRASS is now employed as a design engineer for the Fairchild Engine and Airplane Corp., Fairchild Engine Division, Deer Park, L. I., N. Y.

Brass had been associated with Wright Aeronautical Division of Curtiss-Wright Corp. as an assistant project engineer.

WALTER ROCKWELL, chairman of the board of Acro Manufacturing Co., Columbus, and formerly president of Timken Detroit Axle Co., has returned from a business trip to England and the Continent. While away, he visited present Acro foreign licensees and contacted other switch and control manufacturers.

MERRILL A. HAYDEN has been promoted to general manager of Waterbury Tool, Division of Vickers, Inc. He has been assistant general manager since 1953. Previously he was general sales manager of the Division.

FRED W. BURGIE has been promoted to assistant general sales manager for the Doehler-Jarvis Division of National Lead Co. He formerly was manager of sales of the two Doehler-Jarvis Toledo plants.

GEORGE BENNETT has been elected president of the Borroughs Mfg. Co., Kalamazoo, Mich., a subsidiary of the American Metal Products Co. of Detroit. He has been general manager for the firm.

WESLEY J. BARTA has been made vice-president of Mississippi Valley Barge Line Co., St. Louis. He has been serving as superintendent of maintenance.

Four prominent SAE members were given honorary membership in the American Society of Mechanical Engineers on November 17.

In ASME, honorary membership is conferred for "acknowledged eminence in the engineering field." It has been given to 177 persons since ASME's founding in 1880.

The SAE men so honored last month were: (left to right) James H. Doolittle, Shell Oil Co.; Joseph Bradley Armitage, Kearney & Trecker Corp., an SAE Vice-President for Production; Dr. C. G. A. Rosen, Caterpillar Tractor Co., who was SAE President for 1955; and Clyde Elmer Williams, Battelle Memorial Institute.

A. W. ROSE has been appointed vice-president and general manager of the Petro-Mechanics Research Division of Borg-Warner Corp. He is also a vice-president of Borg-Warner Corp.

He recently returned to the United States after eight months of temporary service as assistant to the chairman of Borg-Warner, Ltd., a subsidiary in Letchworth, England.

ARTHUR C. COCAGNE is now director of field engineering for Whittaker Gyro, Inc. He was assistant to the vice-president in charge of field engineering for the Wm. R. Whittaker Co., Ltd.

MAURICE J. DAY has been elected vice-president of research and development by the board of directors of Crucible Steel Company of America. He has been the company's director of research and development. He will continue to maintain offices in Pittsburgh.

STANLEY E. SHAVEL, formerly with Boeing Airplane Co. as an associate research engineer, is now a project engineer in the Aircraft Gas Turbine Section of the Allison Division, GMC.

ROBERT E. MINTON has become general manager of Republic Aviation International, S. A. at Lugano, Switzerland. He has been facilities coordinator at the Farmingdale, L. I., N. Y. offices.

S. K. HOFFMAN has been named general manager of the newly established Rocketdyne Division, North American Aviation, Inc. The new division is an outgrowth of the company's Propulsion Center formerly headed by Hoffman. It will carry on research, development, and manufacture of high-powered rocket engines and related items.

SAL FRANK ARTINO is now a development engineer for Aerojet-General Corp., Sacramento, Calif. He has been with Cleveland Graphite Bronze Co. as a design engineer.

RALPH F. PEO has announced that Houdaille Industries, Inc. is the new name of the corporation which since 1929 has been known as Houdaille-Hershey Corp. Executive headquarters of the corporation were recently moved to Buffalo, N. Y., where four of the corporation's 12 businesses are located.

HELMA FUHRMANN, project engineer in the Technical Data Section, Detroit Diesel Engine Division, GMC, was the one woman among 400 men to receive their Registered Professional Engineer Certificates. She is the second woman in Michigan to receive the scroll given by the state for passing rigid tests.

Somebody Told Me

by RCSackett

Rave reports are coming back to his associates at Douglas Aircraft's Santa Monica plant about the swellegant trip that **JOHN BUCKWALTER** and family are taking in Europe. They will do Great Britain, France, Germany, Spain, and Italy in the small European car John bought before they get back in September, 1956. Its a 10-year dream come-true of John and Mrs. B. .

STM

You never know where you'll see **"O. E." HUNT** these days. He's gained weight. Is the picture of health. Took in all the new car previews; sees a top football game every Saturday. If you're a salmon fisherman you may see him on the Columbia River in season, or it might be tramping after pheasant in South Dakota.

Then there's "O. E.'s" successor as GMC vice-president of engineering, **JIM CRAWFORD**, SAE Prexy in 1945. Also retired. Jim has gone back to his old love—painting, the fine art kind. And he has plenty of subject matter around La Jolla, Calif. where he and Mrs. Crawford live.

STM

PROF. TOM MURPHY, head of the Internal Combustion Lab, University of Minnesota, removed the cast from his left ankle just before the fall semester started. Nope;—it wasn't football practice. Seems his backyard steps got in the way and cracked a metatarsal bone. He is plenty agile manipulating himself around the lab on crutches. And it hasn't slowed him down in his job of Meetings Committee Chairman for the Twin City Section.

STM

ERNIE LUNDEEN, Inland Steel Co., swapping old times with an A-C Spark Plug man, about the days when Ernie was A-C's first metallurgist,

STM

soon got back to tall tales of Albert Champion. And they're legion. Just to show how bad things are today, the other A-C man said a visitor came in recently and said "If you don't do something about your parking lot, I'm going to take my business somewhere else."

STM

M. R. DENNY, GM Overseas, says that the little air-cooled German Volkswagon is one of the toughest competitors on the Continent. And now the People's-Car volks are going to open a plant in New Jersey.

STM

GRID-IRON, NOT MOLY . . . "Cousin" **VIC CROSBY**, Past SAE Veep for Engineering Materials Activity and Past-Chairman of the Iron and Steel Technical Committee visited his son Dr. Crosby down Atlanta Georgia way last fall. Real urge for the trip was the game between "Ole Miss" (Vic's Alma Mammy) and Georgia. Cousin Vic, you know, is the only alum who ever got an Ole Miss sheepskin without passing Freshman English. He flunked it. Next year they made it a requirement for graduation. It hasn't cramped Vic's rhetorical style that anyone can notice.

GMC's Detroit Diesel Engine Division Appoints Twelve to New Posts


Dickson


Ervin

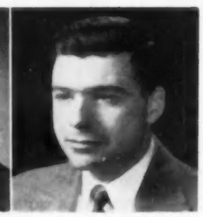

Hazel


Hanley


Adsit


Reddy


Whiteford


Sinks


DeFezzy


Ledwan


Hall


Wellington

Twelve SAE members at Detroit Diesel Engine Division of GMC recently have been appointed to new positions. **C. W. FREDERICK**, director of engineering, has appointed **JOHN DICKSON** staff engineer in charge of forward design and development. In 1954 Dickson served as SAE Vice-President in charge of Diesel Activity and was chairman of the Diesel Activity Committee.

CHARLES E. ERVIN has been appointed chief project engineer. He was project engineer on series "51" engine. **WILLIAM P. HAZEL** is now test engineer supervisor. He was experimental engineer in the Division Laboratory. **GEORGE P. HANLEY** has been promoted from assistant to supervisor of basic engine design. At one time he was SAE Faculty Adviser at the University of Detroit.

RAYMOND M. ADSIT, formerly experimental engineer in charge of model "51" engine laboratory tests, has been placed in charge of field testing of basic engines in various applications.

VIRGIN C. REDDY is director of development in charge of all development work in the laboratory. He was development engineer in charge of basic engine development.

ROBERT W. WHITEFORD has been appointed development engineer of a basic engine group. He has been project engineer in charge of series "71" engine. **FRANK SINKS** is now application engineer in charge of truck, bus, and tractors.

ALBERT DEFEZZY has been appointed director of drafting. He had been general supervisor of basic engine design. **NORMAN H. LEDWAN** has been promoted from assistant to project engineer in charge of series "51" engines.

JAMES A. HALL is staff engineer in charge of development and testing in the laboratory. He was head of the experimental section. **ROGER WELLINGTON** has been appointed director of test engineering in the laboratory. He was co-author of an SAE "51" engine paper with John Dickson.

RICHARD R. BEY, formerly a designer for the Saginaw Steering Gear Division of GMC, has joined the Ford Motor Co. Engineering Staff as a product test engineer in Special Products Department.

DORMAN B. DICKERSON, JR. is now associated with Essex Wire Co. in Detroit. He has been with P. R. Mallory Co., Inc. of Indianapolis as manager of tools and equipment.

IRVIN G. DETRA is now associated with New Process Gear Corp. of Syracuse, N. Y. as head, Design and Development Department. He had been with Oliver Corp. of Charles City, Iowa as a project engineer.

DR. A. B. KINZEL has been elected a vice-president by United Engineering Trustees, Inc., New York City. He is vice-president — Research of Union Carbide and Carbon Corp.

MELVIN W. HALL is now chief inspector for Reynolds Metals Co. Extrusion Plant, Phoenix, Ariz. He has been regional sales manager, Western Region, for the same company.

Hall has held many offices in the Southern California Section of SAE. He served as Student activity chairman for three years and as House chairman for two years.

ARTHUR C. BODEAU is now chief engineer of Ford Motor Co.'s Research Division. He has been a research engineer for the Division.

OTTO J. DOEPEL, semi-retired in Venice, Fla., is serving in sales engineering as a manufacturers' representative. He had been chief engineer and purchasing agent for Metal Products Co. of Miami, Fla.

JOHN T. BROWN, president of J. I. Case Co.; and **ROY A. FRUEHAUF**, president of Freuhauf Trailer Co. have been included on a newly established board of trustees for Keep America Beautiful, Inc. KAB is a national public service organization for the prevention of litter.

W. L. AIKEN has been appointed senior automotive engineer for SKF Industries, Inc. He will be located at the firm's Detroit office.

He has been senior division engineer at the Philadelphia plant.

JAMES G. MORROW, metallurgical engineer, The Steel Co. of Canada, Ltd., has been awarded the American Standards Association Standards Medal. It was given to Morrow for "his leadership in the development and application of standards."

GEORGE H. KELLER has been with the engineering division of Wright Aeronautical Division of Curtiss-Wright Corp. for some 15 years . . . and is now assistant chief engineer of Wright. He joined SAE in 1937.

GEORGE KELLER, JR. (M '32) who previously was chief engineer of Trucktor Corp., is now with the Kearfott Co., Inc. of Little Falls, N. J. as project engineer, Tools & Test Equipment.

(In the November SAE Journal, the item printed about George Keller, Jr. incorrectly indicated that he had previously been a member of the Wright organization.)

EDWARD A. KRUSZYNSKI is now executive vice-president of LaFrance Mfg. Co., St. Louis, Mo. He is also in charge of development and sales.

Kruszynski has been a salesman and chemist for the company.

CARL HALPIN, industrial engineer, has joined Lunn Laminates, Inc., Huntington Station, N. Y., as sales engineering representative. He was general manager and owner of Carl Halpin Industrial Engineers, Detroit.

JOHN F. GORDON, group executive and director of GMC, will be general chairman of a campaign to raise funds to support the 1956 program of Junior Achievement of Southeastern Michigan.

Gordon has said that JA now has 6000 boys and girls in southeastern Michigan operating 274 business corporations. Many thousands of teenagers cannot be accepted as Achievers due to limited facilities.

DR. R. P. DINSMORE, vice-president in charge of research and development at the Goodyear Tire and Rubber Co., was awarded the 1955 Charles Goodyear Medal, highest honor in rubber chemistry. (left)

The medal, presented annually by the Division of Rubber Chemistry, American Chemical Society, is awarded to a person who has made a valuable contribution to the science of technology of rubber or related subjects.

DONALD R. SPOTZ has been appointed general sales manager of Pesco Products Division of Borg-Warner Corp. He had been sales manager of the Accessories Division of Thompson Products, Inc.

HENRY C. TRICH has resigned as sales manager for the Hydraulic Division of Parker Aircraft Co. to devote his full time to his own business, Western Gravity Casting Co., Los Angeles.

KENNETH P. KIRCHOFF is now a project engineer, advanced engineering department, Studebaker-Packard Corp., Detroit. He had been senior project engineer for the Detroit Transmission Division of GMC, Ypsilanti, Mich.

FRED G. HEIDERER is now affiliated with Allison Division, GMC, as a sales engineer in the Dayton zone office. He was a special representative with the Buick Motor Division of GMC.

Obituaries

MELBOURNE L. CARPENTIER

Melbourne L. Carpentier, assistant chief chassis engineer in charge of engine design for Chrysler Corp., died Oct. 18.

Early in his career, Carpentier became associated with Fred M. Zeder, Carl Breer, and Owen R. Skelton, Chrysler's famed engineering trio. The group later established an independent engineering firm in Newark, N. J., and subsequently was engaged by Walter P. Chrysler. Carpentier worked on the design of the first Chrysler engine.

His direction of Marine and Industrial engines has helped to make Chrysler a respected name in that industry.

SAE welcomed his abilities to Drafting Standards Committee work especially. He was a member of the Automotive Drafting Standards Steering Committee, chairman of the Editorial Subcommittee, and chairman of the Microfilming Subcommittee.

General Motors also welcomed him to their Drafting Standards Subcommittee and various technical subgroups of that subcommittee including the Editing Subgroup.

GEORGE R. ERICSON

George Robert Ericson died Oct. 22 at Deaconess Hospital in St. Louis.

He was born in Shelby County, graduated from George Washington University in Law. Since 1928 he had been patent counsel for Carter Carburetor Corp. in St. Louis and for several years, during the same time, patent counsel for American Car and Foundry Co. of New York. Ericson had been admitted to practice before the Supreme Court and was well known for his many inventions and patents.

He was a World War I veteran, member of Tuscan #360 Lodge and the Scottish Rite in Kirkwood, Miss. He was a member of the SAE since 1932 and held the office of chairman of the St. Louis Section in 1939–40.

ELBERT FOWLER

Elbert Fowler, consulting engineer, Elyria, Ohio, died September 22.

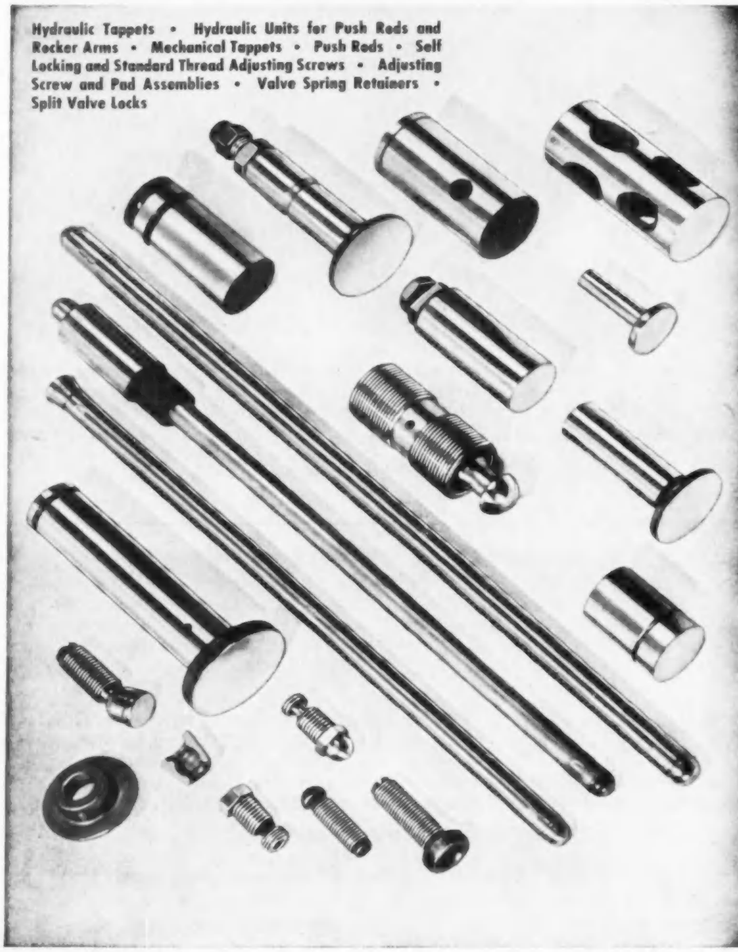
When he joined SAE in 1943, Fowler was chief engineer of the Pump & Compressor Division of Rogers Diesel & Aircraft Corp., New York.

Prior to that he had been staff engineer, development and research, for Bendix-Westinghouse Automotive Air Brake Co., Elyria; technical advisor for Bender Body Co., Elyria; mathematician at the County Engineers Office, Cleveland; chief engineer, Romec Pump Co., Eylria; designer for Arthur McKee Co., Cleveland; engineer for International Flare Signal Co., Tippecanoe City, Ohio; chief engineer, Barrett-Craven Co., Chicago; vice-president

CONTINUED ON PAGE 110

"CHICAGO"
precision valve gear parts

•STEEL •CAST IRON •STEEL and IRON



Connecting Rod Bolts..........Hydraulic Cylinder Pistons
Cylinder Head Studs..........Cylinder Head Cap Screws
Main Bearing Studs..........Main Bearing Cap Screws
Flywheel to Crankshaft Screws..........Diesel Energy Cells
Wheel Bolts and Studs..........Differential Carrier Screws
Oil Pump to Distributor Shafts..........Rocker Arm Shafts
Automatic Transmission Valves..........Water Pump Shafts
Roller Followers..........Ball Joint Assemblies

External and Internal Grinding, Thread Grinding, Precision Roll Threading

Heat Treating • Carbon Restoration • Carburizing • Carbo Nitriding • Cyaniding • Hydrogen Brazing • Complete Metallurigcal, Dynamometer and Testing Laboratories

Special Screw Machine Parts 1/16" to 5" Diameter
• Cold Upset 3/16" to 1" Diameter • Cap Screws
• Set Screws • Nuts • Studs • Taper Pins
• Socket Screw Products

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2521 WASHINGTON BLVD.
BELLWOOD, ILLINOIS
Established 1872

Sections

Continued from page 88

three of the several wind tunnels at the Sunnyvale, Calif. laboratory including the 14 ft. transonic, the huge 40 × 80 low velocity, and the new unitary tunnel.

The new unitary tunnel is believed to be the largest supersonic tunnel for aerodynamic research functioning anywhere in the world, and will be used primarily for development work. A bank of electric motors, which can deliver 180,000 hp continuously or as much as 216,000 hp for one hour, drives two large compressors circulating air through the tunnels at velocities from 500 to 2430 mph.

The NACA guides, engineers employed at the lab, made good use of the well built models of the tunnels in the tour of the facilities. The field trip was enjoyed by all, and our thanks to the NACA for their excellent handling of the 1955 trip.

The day was topped off with a dinner meeting at San Mateo's Benjamin Franklin Hotel.

No. California Section
South Bay Division

Howard G. Leonard (center) appears with **F. L. Jarrett** (left), Northern California Section South Bay Division vice-chairman; and **W. G. Brown** (right), Northern California Section chairman.

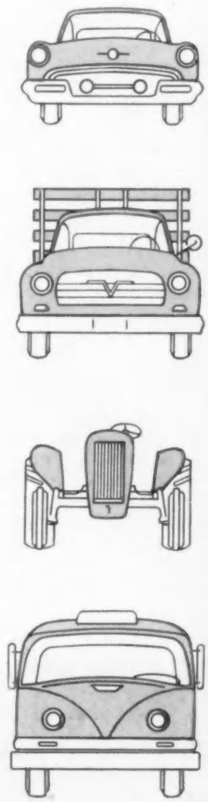
HOWARD G. LEONARD was the guest of honor at the South Bay Division Dec. 6 meeting. Those present had the privilege and honor of seeing him presented with a certificate for recognition of more than 35 years as an active member.

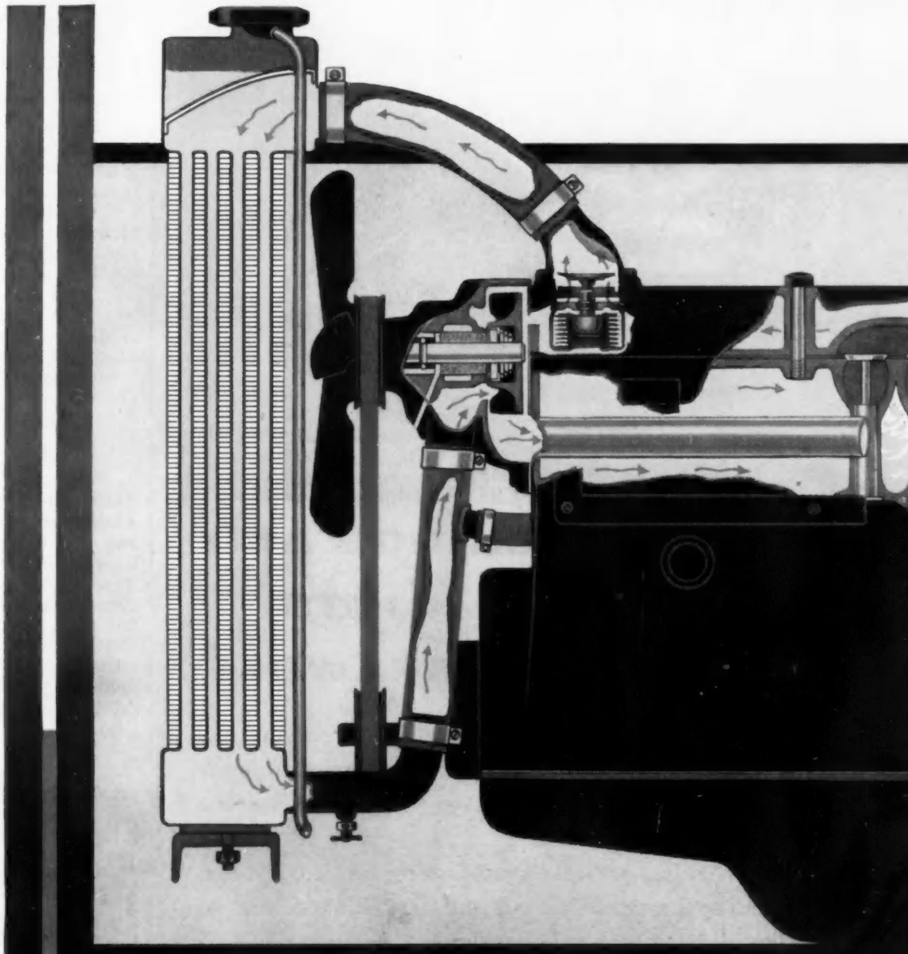
The certificate was presented by W. G. Brown, chairman of No. California Section.

Prof. Leonard was a member of the

CONTINUED ON PAGE 98

HARRISON COVERS THE WATERFRONT!





From family car to farm tractor . . . Harrison takes the heat off high-powered engines. A compact, highly efficient Harrison radiator plus an accurate, dependable Harrison thermostat assures the *right* temperature for the most efficient operation of these power plants. That's why leading automotive manufacturers specify Harrison. They know from long experience that Harrison products are engineered for dependable, economical service. In fact, Harrison heat control products are backed by more than 44 years of research and manufacturing experience. If you have a hot or cold problem, look to Harrison for the answer.

GM
GENERAL MOTORS

TEMPERATURES MADE TO ORDER

HARRISON

RADIATOR DIVISION, GENERAL MOTORS CORPORATION, LOCKPORT, N. Y.


Launching of the atomic powered submarine Seawolf at Groton, Conn.

GARLOCK PACKINGS AND EXPANSION JOINTS USED ON U.S.S. SEAWOLF

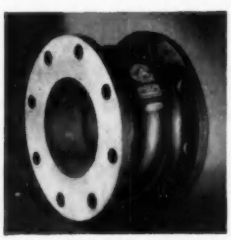
The Electric Boat Division of General Dynamics Corporation has relied on Garlock packings, gaskets, and rubber expansion joints for *both* of their atomic powered submarines—first on the Nautilus and now on the Seawolf.

You, too, can depend on Garlock products for long, trouble-free service on your applications. Just call your Garlock representative . . . consult with him about your packing requirements.

*Registered Trademark

Left: Garlock CHEVRON* Packing used on the Seawolf for stuffing boxes of hull fittings, including periscope, masts, and antenna.

Right: Garlock expansion joint, neoprene lined and covered. This type was installed on the Seawolf's lubrication and fresh water lines.



THE GARLOCK PACKING COMPANY, PALMYRA, N. Y.

Sales Offices and Warehouses: Baltimore, Birmingham, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Denver, Detroit, Houston, Los Angeles, New Orleans, New York City, Palmyra (N.Y.), Philadelphia, Pittsburgh, Portland (Oregon), Salt Lake City, San Francisco, St. Louis, Seattle, Spokane, Tulsa.

In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.

GARLOCK

PACKINGS, GASKETS, OIL SEALS, MECHANICAL SEALS, RUBBER EXPANSION JOINTS

Sections

Continued from page 96

Leonard Tractor Co. of Jackson, Mich. in 1917. There he helped with the development of a four-wheel drive tractor. In 1922 he moved to the Rocky Mountain area to live, and worked in engineering sales. In 1934, he joined the U. S. Army Corps of Engineers. He was with the Corps until 1952 when he joined the faculty of the University of Santa Clara. This last summer he again became affiliated with the Corps.

After receiving the certificate, Prof. Leonard spoke on the developments in the automotive field during the past 35 years.

TO HELP STUDENTS FEEL A PART OF SAE and South Bay Division, two student members are invited to attend each Division technical meeting. This has been a great asset to all concerned, because students can get the feel of full membership activities, good contacts, and future employment possibilities. The member can better understand the student problems and activities, and lend an experienced helping hand.

Mid-Michigan

G. W. Colby, Field Editor

Hows & Whys In Program Planning

Would you like to hear about new turbo-prop planes from a vice-president in charge of airline operations?

Would you like your best gal to accompany you at an SAE Meeting to see the new General Motors Dream Cars? The Program Committee of the Mid-Michigan Section felt that the answers to these questions by members of the Section would be in the affirmative. Accordingly, these two programs were among those adopted for the 1955–1956 Section meetings.

In an effort to obtain good attendance at meetings, the committee strived to choose current subjects of interest in the industry. To help obtain variety, one of the topics chosen was one not normally considered to be in the field of automotive engineering.

After topics were selected, great emphasis was placed on securing dynamic speakers. The success of a meeting depends in a large part on the ability of the speaker to capture the

CONTINUED ON PAGE 100

new LONG LIFE PISTON

★ **Low initial cost**

★ **Light weight**

★ **Amazing increase in piston life**

★ **Maintains new engine power and performance**

This Gillett & Eaton exclusive steel wire insert is cast right into the alloy piston to make hard surfaces for the top ring groove. Here's an entirely new piston design combining all the advantages of aluminum alloy with the long life of steel wire bearing surfaces in the top ring groove. No noticeable increase in weight. G and E Wire Insert Pistons are real top performers at Low Cost—barely more than ordinary alloy pistons!

When the grooves are machined, the closely spaced steel wire inserts cast in the piston become hard bearing surfaces on top and bottom faces of the groove. The wire insert also strengthens the second ring land.

Engines fitted with Gillett & Eaton Wire Insert Pistons *maintain* new engine power and performance much longer because top ring groove wear is reduced to a minimum. Build extra volume and profits at Low Cost with Gillett & Eaton Wire Insert Pistons.

GET THE G AND E WIRE INSERT STORY—Send your specifications and requirements—let us quote you.

GILLETT AND EATON, INC. 825 DOUGHTY STREET • LAKE CITY, MINN.

ESTABLISHED 1868

Sections

Continued from page 98

audience.

The use of displays, exhibits, and models is encouraged. For example, at a recent meeting on the "Development of the Automobile," a display of over a dozen cars of 1920–1925 vintage helped to make this meeting most successful.

Plant tours are desirable, especially where there is a natural tie-in between the subject presented and its manufacture.

Ladies Night has met with tremendous success. It is the policy of the Mid-Michigan Section to schedule one meeting of this type each year. At the 1956 meeting, a GM stylist will present a discussion on styling. The Motorama Dream Cars will also be on exhibit.

A short social period sometimes precedes the meetings. Such periods enable new members to become acquainted with other members of the Section.

The results of these ideas have been most gratifying, with attendance growing by leaps and bounds. Of 318 total members in the Section, the average attendance including guests, but not students, is 171. The average percentage of members attending the meetings is a husky 45%.

MILES G. HANSON was presented a 35-year Membership Certificate as a highlight of the Nov. 14 meeting. Prior to his retirement two years ago, Hanson had received distinction as an assistant works manager at AC Spark Plug Division, GMC.

AN SAE DISPLAY was set up by Mid-Michigan Section for the Centennial of Farm Mechanization at Michigan State University. The Centennial, lasting six days, drew over 300,000 people.

CHICAGO

P. P. Polko, Field Editor

Chicago Sets Up A "Sales" Department

—Wyn E. McCoy

No company or product will long survive regardless of its merits unless it is supported by an active and aggressive promotion policy. This basic philosophy also applies to SAE.

The problems of keeping SAE a live, dynamic, and progressive organization

CONTINUED ON PAGE 102

DU PONT
REG. U. S. PAT. OFF.
Better Things for Better Living
. . . through Chemistry

AUTOMOTIVE ENGINEERING NEWS
PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

4 reasons for the expanded use of ZYTEL® nylon resin in 1956 models

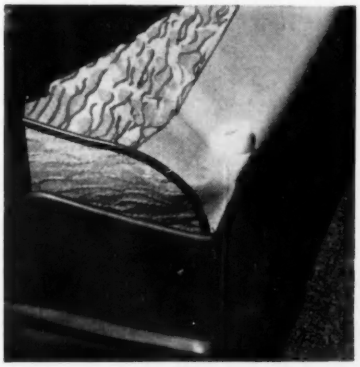
Every day, automotive engineers are selecting Du Pont "Zytel" nylon resin to replace conventional materials to produce better parts—in performance, durability and cost of manufacture.

Here are typical properties of "Zytel" that make improved parts possible.

- **Excellent abrasion resistance**
- **Light in weight**
- **Requires little or no lubrication**
- **Tough, even in thin sections**
- **Heat-resistant**
- **Resilient**
- **Economical production (molded in multi-cavity dies)**

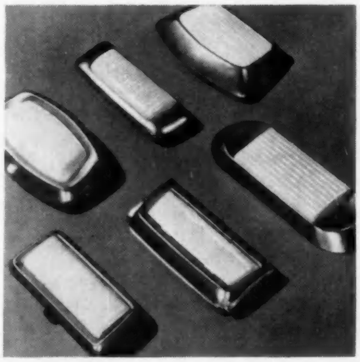
There are still other advantages in using "Zytel." For example, colors are molded right into the part—no danger of chipping or peeling off. And a single molded piece of "Zytel" can often replace a complex assembly of component parts. That means lower unit cost, faster production. Usually, no further finishing of the part is required after the molding operation.

It will pay you to examine your own automotive design requirements with "Zytel" in mind. Perhaps you can replace a component part with one of "Zytel". . . lower your production costs and gain new selling points. Find out how the properties and applications of "Zytel" can help you. Send in the coupon for complete information.

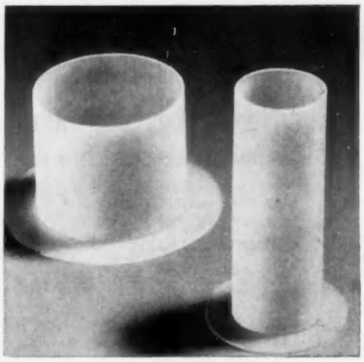


STRENGTH OF "ZYTEL" is seen in its support of the front seat. This backstop of "Zytel" is subject to constant impact and pressure, yet it will give years of trouble-free service.

RESILIENCE OF "ZYTEL" is demonstrated by this door-lock wedge. Each time the door is slammed, it absorbs the shock. The wedge keeps its shape and holds the door closed.



HEAT RESISTANCE OF "ZYTEL" is excellent for applications such as these dome light lenses. Parts made of "Zytel" nylon resin can operate at temperatures as high as 250°F.



WEAR RESISTANCE OF "ZYTEL" is shown by brake-pedal bushing. It needs little or no lubrication. Low coefficient of friction and abrasion resistance of "Zytel" permit this.

NEED MORE INFORMATION?

CLIP THE COUPON for additional data on the properties and applications of these Du Pont engineering materials.

"Zytel," "Teflon," "Alathon" and "Lucite" are registered trade-marks of E. I. du Pont de Nemours & Co. (Inc.).

E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department
Room 461, Du Pont Building, Wilmington 98, Delaware
In Canada: Du Pont Company of Canada Limited, P.O. Box 660, Montreal, Quebec.

Please send me more information on the Du Pont engineering materials checked: ☐ "Zytel"* nylon resin; ☐ "Teflon"* tetrafluoroethylene resin; ☐ "Alathon"* polyethylene resin; ☐ "Lucite"* acrylic resin. I am interested in evaluating these materials for ________

NAME ________
COMPANY ________ POSITION ________
STREET ________
CITY ________ STATE ________
TYPE OF BUSINESS ________

A puzzling design problem finds a Clark solution . . .

Charlie King speaking:

A leading manufacturer of farm equipment said to us, a few years back, "We know the job a tractor has to do—you fellows know the transmission of engine-power to wheels. Our tractor is good, but we intend to make it better. You design a drive-train for it." We did so—pooled their experience and ours, scrapped all conventional ideas, created an axle-transmission drive unit of wholly new functional design. That unit "licked" their problem. They still use it. We make it.

A manufacturer of road machinery heard about that deal, and asked us to do the same for him. We did—an intelligent job of collaboration. He likes his Clark drive unit, and we like the business we get.

Those two instances of mutual benefit point up the basic usefulness of Clark Equipment: We are "problem solvers"—problems concerning the delivery of engine power to the point of application.

C. H. King

We have solved many such, including problems encountered in building our own materials handling and construction machinery.

Essentially, we sell experience. We sell good engineering, good plant facilities, and a zeal for good workmanship. Finally, we sell an awareness that we must keep a step or two ahead in anticipating *what our customers are going to need next!*

This may explain why so many excellent concerns look upon it as *good business to do business with Clark.* If you have a difficult-to-solve problem, bring it to Power Train headquarters. Write Clark.

CLARK® EQUIPMENT

CLARK EQUIPMENT COMPANY
BUCHANAN 5, MICHIGAN
Other Plants: Battle Creek, Jackson, Benton Harbor, Michigan

Sections

Continued from page 100

are no different than those experienced in any first class company or corporation.

It is the definite responsibility of the Membership and Plant Representatives Committee to "sell" SAE to qualified prospects. Since this is very definitely a selling operation, Chicago Section has organized its Membership Committee with this basic thought in mind.

Committee Organization

The Membership Committee is composed of approximately twelve co-chairmen who, for the most part, are sales engineers or people who have wide contacts and the ability to generate enthusiasm for SAE. Each of the co-chairmen will work directly with ten to fifteen Plant Representatives who will be located in the various plants in the Chicago Section.

We believe this procedure has been very effective in stimulating interest in SAE in many locations where previously there had been little, if any, real membership activity or promotional work done.

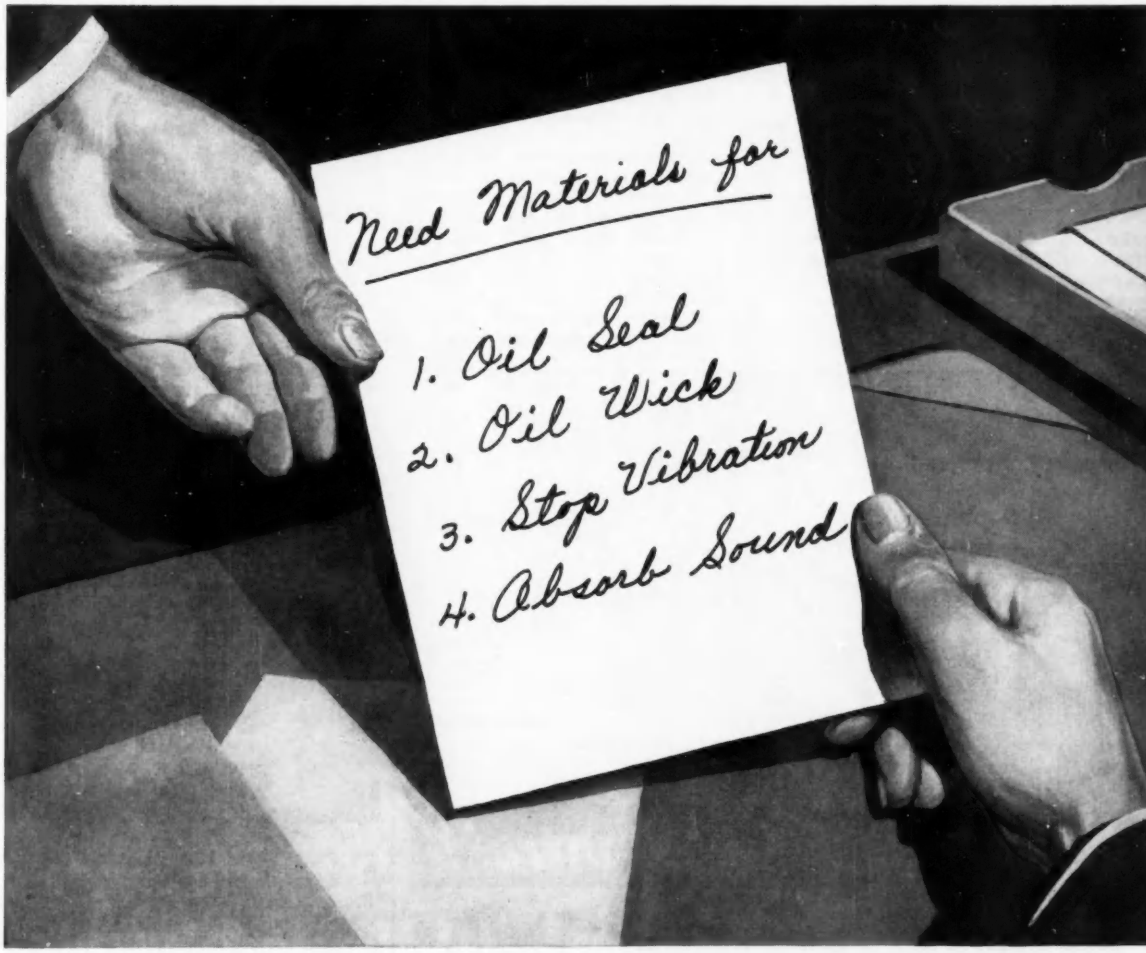
Promotional Letters

Last year we found a very effective technique to stimulate membership. We sent out a general letter as an appeal to each SAE member in the Chicago Section to place an enclosed application blank and SAE literature in the hands of a qualified prospective member. This general letter was mailed to each member in the Chicago Section along with the monthly SAE Chicago Section News. The support we received from the general membership on this promotional campaign was very encouraging. The requests for SAE membership took a substantial jump following this project.

A Display Board

As a focal point for generating interest in SAE membership at our monthly Section meetings, we have constructed a display board which is mounted at a conspicuous location. This display board is 6 feet wide and 4 feet high. It is brightly illuminated with a neon light and carries the heading PRIVILEGES OF SAE MEMBERSHIP. On this board we have mounted the Handbook, Journal, and Transactions. We have shelves for the various types of SAE general promotional literature and, of course, an ample supply of application blanks. We also display

CONTINUED ON PAGE 104



for all four
Your best answer is

Felt

Western Felts can be made as soft as virgin wool or as hard as bone—or any desired specifications in between. But always, their live fibers hold their shape. They never ravel or fray . . . resist wear, age, and weather.

For over 56 years Western Felt has manufactured and cut specification felts for all industries. Whatever your problem, our experience can be helpful. Let our engineers investigate that possibility for you.

WESTERN Felt WORKS
4021-4139 Ogden Ave
Chicago 23, Illinois
Branches in all Principal Cities

MANUFACTURERS AND CUTTERS OF WOOL FELT

Sections

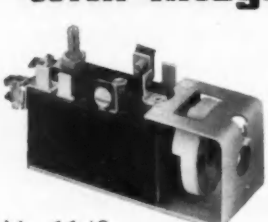
Continued from page 102

application cards for SAE Placement Service and indicate currently the number of positions available and also the approximate number of men available—pointing out that these are all services and privileges of SAE. This display board has attracted considerable attention and genuinely helps to dramatize the value of SAE membership.

These various programs which we have undertaken are definitely beginning to bear fruit. We are showing a substantial increase in new members. There is little doubt that with the continued enthusiasm of our Membership Committee, the Chicago Section will be a strong contender for first place in the Heavyweight Division with regard to membership standing.

3 in 1 Control!

FASCO HEADLAMP SWITCH with Integral Circuit Breakers



No. 1148

Available for both 6 and 12 Volt systems.

It's new . . . but already this FASCO Headlamp Switch is accepted as "standard" by leading automotive manufacturers . . . proof of its dependable, trouble-free performance. Like all FASCO automotive electrical components, this 1148 Switch is designed right . . . built right, to meet the rigid requirements of today's cars and trucks. And that's why design engineers agree it pays to—

CONSULT FASCO . . . FIRST!

AUTOMOTIVE DIVISION

FASCO INDUSTRIES, INC.

ROCHESTER 2, NEW YORK

DETROIT OFFICE—12737 PURITAN—PHONE: UN 17476

So. California

W. E. Achor, Field Editor

NEW MEMBERS attending Southern California Section meetings are introduced by the Section chairman and presented with SAE membership pins.

AN INVITATION has been extended to SAE members attending Southern California meetings to introduce their guests from the floor during the opening period of the meetings.

GOODYEAR TIRE AND RUBBER CO. conducted a plant tour for 157 members of So. California Section on Nov. 30. The group observed the manufacturing processes of numerous rubber products.

Syracuse

Clarence Hornbeck, Field Editor

AN INFORMAL MEETING OF OFFICERS of the Section was held to discuss results of a questionnaire recently sent to members. The effort has been to establish features of meetings most desired.

Further discussion on attendance brought out suggestions that individuals within principal industries contact prospective members, more speakers be invited from local industry, and high ranking local executives be invited so that they may become better acquainted with the aims and activities of the Society.

CANADIAN

F. G. King, Field Editor

THE STRENGTH AND VITALITY of this Section is due in no small way to the remarkable number of members who have continued to participate in its activities from its earliest years. They built the foundation and have contributed greatly to the Section's growth and well-being.

Due recognition was given to members such as these in presentation of certificates in recognition of their

CONTINUED ON PAGE 106

Foremost in ECONOMY

STROMBERG

AMERICA'S FINEST

CARBURETOR

For two consecutive years, the grueling Mobilgas Economy Run has been won by a STROMBERG-equipped Studebaker.

Economy is a magic word in the automobile business. Economy of operation is a mighty sales clincher in any dealer's showroom. Economy in manufacture is vital to protect the narrow profit margin of the auto maker. *The Stromberg Carburetor offers you both.*

Stromberg's system of consistent fuel metering results in economy of operation unmatched by any other carburetor. Automotive experts know it. Fuel consumption statistics prove it. And two consecutive victories for Stromberg-equipped cars in the famed Mobilgas Economy Run confirm it.

But Stromberg can mean even more as an economy factor for the manufacturer Because of the vast number of *different* carburetor models which Stromberg makes available to manufacturers, a Stromberg Carburetor can usually be selected to fit the needs of any engine with a minimum of costly revisions.

For more than forty years, Stromberg has been the American leader in every phase of carburetion. More advances in this field have been initiated by Stromberg than by any other manufacturer.

The STROMBERG application engineer will be happy to discuss carburetion problems with you at your convenience.

The folks who make Stromberg Carburetors enjoy tackling a difficult problem—because when you have a problem we can solve, everyone is happy. You have a better product, we have a satisfied customer, and the motorist has a more efficient automobile.

Call on us. The Stromberg application engineer is at your service. You'll find he knows his business—and he may help build yours.

ECLIPSE MACHINE DIVISION OF BENDIX AVIATION CORPORATION

Original Equipment Sales: Elmira, N. Y. • Service Sales: South Bend, Ind.
Export Sales and Service: Bendix International Division, 205 E. 42nd Street, N. Y. 17, N. Y.

Stromberg* Carburetor

Bendix* Electric Fuel Pump   Bendix* Folo-Thru Starter Drive

*REG. U. S. PAT. OFF.

ECLIPSE MACHINE DIVISION

Bendix AVIATION CORPORATION

Sections

Continued from page 88

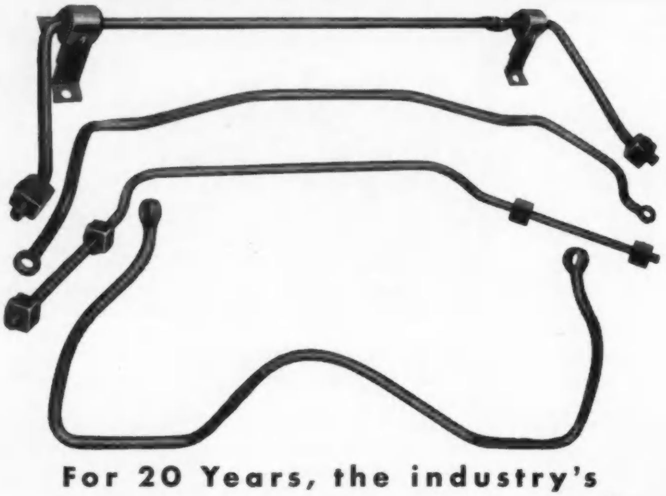
milestones.

A 35-year Membership Certificate was presented to **Warren B. Hastings**, Ontario Motor League and Canadian Automobile Association.

Certificates for 25-year membership were presented to nine members. They are **Josef K. Chmel**, Prenco Progress & Engineering Corp.; **Horace Harpham**, Harpham Brothers; **Albert Olson**, consulting engineer; **Arthur W. Frazer**, Provincial Institute of Trades; **R. W. Richards**, Goodyear Tire and Rubber Co. of Canada, Ltd.; **James C. Armer**, Dominion Forge & Stamping Co.; **Gordon McIntyre**, Imperial Oil, Ltd.; and **Norman H. Daniel**, retired. (See photos on page 84.) **D. A. Ross**, McQuay-Norris Mfg. Co. of Canada, also received a 25-year Membership Certificate, although he does not appear in the photos.

MONROE

SWAY BARS TORSION BARS LATERAL STRUTS



For 20 Years, the industry's major source of Bars and Struts

Monroe builds bars and lateral struts to every form, shape and size used in the automotive industry. Fifteen makes of cars and trucks specify Monroe bars . . . With the highest degree of Automation in the industry, Monroe's special high-production facilities are best able to produce bars and struts to your specifications and delivery requirements . . . A letter or phone call will bring a Monroe engineer to your plant for a thorough discussion of your needs.

MONROE AUTO EQUIPMENT COMPANY

Monroe, Michigan—World's Largest Maker of Ride Control Products

DETROIT

W. F. Sherman, Field Editor

CHRYSLER INSTITUTE OF ENGINEERING STUDENT BRANCH is planning its meetings as a series to directly meet the interests of the students. A poll was recently taken to determine these interests as closely as possible.

The first meeting of the series was attended by more than 100 students representing Chrysler Institute Graduate School, Wayne University, and Lawrence Institute.

Oregon

OREGON STATE COLLEGE STUDENT BRANCH held a field trip in Portland on Nov. 18. They spent the morning visiting the Willamette Iron & Steel Co. In the afternoon they explored the extrusion mill of the Aluminum Co. of America in Vancouver, Wash. The evening was spent previewing an auto show just opening in Portland.

SAE Student Branch Outside Section Territory

UNIVERSITY OF MIAMI STUDENT BRANCH almost doubled its membership during registration for the fall semester. The branch set up a table outside of the engineering students' adviser's room where they could reach all of the engineering students as they registered.

This is the group's first semester as a Student Branch. It has operated as the University of Miami Student Club since 1953. The chairman of this new Branch is Richard Partin. Prof. John D. Gill is serving as Faculty Adviser.

Meetings are held every two or three weeks with a guest speaker and usually a movie. Field trips are planned each year to places such as Pan American engine overhaul plant, Shelly Tractor Co., and the General Motors Motorama. Each spring an Economy Run is held, with prizes donated by local businessmen.

Sections

Continued from page 83

(a) To have readily accessible, records to assist incoming officers and chairmen of committees.

(b) To save some records for 25-year and 50-year anniversaries.

Letters to past Section chairmen, asking them to reminisce for not more than one typewritten page, on the most interesting and outstanding meetings during their term of office, might prove very interesting for reference and for anniversaries.

The heart and core of our Archives consists of a set of loose-leaf (3-holed) binders containing a complete set of our meeting announcements. (The difficulty we had in collecting these for the past 25 years emphasized the importance of doing this now.) Later, it would probably be impossible. Newer Sections will find it far easier if they profit by our previous laxity.

Since the meeting announcements carry dates, subjects, speakers' names, etc., these meeting announcements provide a fairly comprehensive record of every meeting and they have settled many friendly arguments.

In these loose-leaf binders, one sheet of white paper is inserted adjacent to each meeting announcement. This provides space for the Section secretary to record the number at the dinner, the number at the meeting, and any other information thought pertinent. Changes in speakers, etc., sometimes occur. This page also provides space for pasting on newspaper clippings, published prior and after the meeting.

Then if the Meetings Chairman is contemplating piston rings as a subject, he can glance through these binders and see whether the subject was a "ringer" or whether it missed the pin.

The use of loose-leaf binders seems desirable, until we have longer experience with the Archives.

Seeking Competent Counsel

Of course, our first step was to write to New York SAE Headquarters to learn what other Sections had done. The answer seems to have been "very little," which is the reason for this report.

Hollister Moore, manager of the Sections and Membership Division, gave us the name of the "historian" of one Section, who did not answer our letter. One of the West Coast Sections also had a historian (many years ago) who collected a scrapbook of Section activities that was very interesting.

We also checked with the Archivist of R.K.D. Club at Mellon Institute of Pittsburgh who suggested a folder in the files for each committee chairman—a very good idea.

To prevent these folders from becoming too crowded, a 5-year limit is suggested on correspondence and other material filed in these folders.

When organizing the Archives, each committee chairman should be asked what should be kept in the folder (which represents his committee) so that when a new chairman is appointed for that committee, he can refer to the previous work done by that same committee.

Folders might be provided for—

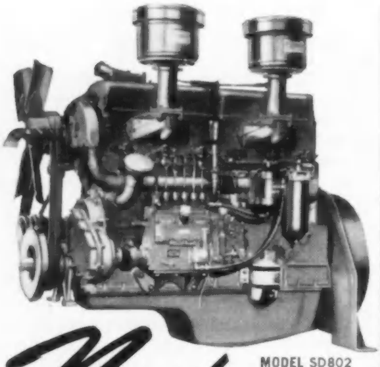
(a) Minutes of Governing Board
(b) Arrangements Committee
(c) Program Committee
(d) Speakers' Papers
(e) Public Relations
(f) SAE Journal
(g) Photos

CONTINUED ON PAGE 108

MONROE
WORKING RUBBER
For Every Purpose

Monroe's vast experience in producing injection molded and extruded rubber parts for the automotive industry is at your service. Thru the years we have produced *working* rubber parts of the highest physical strength, to very close tolerances, in practically unlimited design. We use all types and combinations of synthetic and natural rubbers. Rubber-to-metal adhesion parts a specialty. Our engineers will gladly discuss your Molded Rubber requirements with you.

MONROE AUTO EQUIPMENT COMPANY
Monroe, Michigan—World's Largest Maker of Ride Control Products



Now...

*TM REG. RED SEAL

CUSHIONED POWER

DIESELS

for Every TRANSPORTATION and INDUSTRIAL JOB

Red Seal Cushioned Power* Diesels are getting the call for more and more of the really tough jobs, not only in transportation, but in industry, in construction, and on the farm. Why? Because Cushioned Power Diesels provide ALL the advantages of the Diesel principle, with none of the drawbacks common to Diesels of conventional design. You'll be far ahead, all the way, standardizing on equipment built around dependable Red Seal Cushioned Power—or using it to replace heavier Diesels of conventional design.

ONLY CONTINENTAL CUSHIONED POWER* DIESELS GIVE YOU ALL THESE SUPERIORITIES

HIGH ECONOMY . . . due to higher combustion efficiency • MORE USEFUL POWER . . . pressure on pistons applied at most effective crank angle • REDUCED PRESSURE PEAKS . . . for smoother, quieter running, and long life of parts • SELF-CLEANING NOZZLES . . . automatically cleaned with each injection; assure smoother running • LOW UPKEEP COSTS . . . reduced pressures permit use of lower cost high production parts • EASY STARTS ON DIESEL FUEL . . . no auxiliary power needed.

Continental Motors Corporation

MUSKEGON AND DETROIT

Sections

Continued from page 107

Also, keep in file, old check books and Section Rosters.

Consider a new Program Committee chairman. . . . He can go to Program folder and find letters which will be helpful in lining up speakers for meetings during his term.

In this folder, he will also find suggestions (which have been made at Governing Board meetings) for speakers and subjects which were not "ripe" at the time the suggestion was made, but which may eminently ripen a year or so later.

Bright ideas frequently pop up at Governing Board meetings. When they do, much time and trouble may be saved if the answers are available to "Has this ever been tried before by our Section? If so, what were the results? How could it be done better?"

Sometimes a speaker's talk arouses so much interest, that requests are received to see the speaker's paper—some time after the meeting. Who has it?

But with the Archives, used to "centralize" Section records, the Section is not made to look foolish by having to give "guesses and don't know" answers. Whenever a Section member borrows a speaker's paper, we suggest that he sign a followup card, promising to return the paper within a limited time, in case others might wish to see it.

The time came to us, as it will to other Sections, when we wished to celebrate our Silver Anniversary. We used the Archives to assist in securing photos of all our past chairmen to put in a special edition of our Roster, and on which we put a silver cover.

The Archives also furnished source material for a full two-page spread in the Sunday Press, one of Pittsburgh's two largest newspapers, telling all about the Pittsburgh Section.

Thirty-two technical societies are represented in our city. But we do not recall any of them having received so much favorable publicity. May we modestly say, "Never have so few received so much publicity from so many."

SINCE 1907

PARK

QUALITY DIE FORGINGS

FROM VITAL AVIATION DROP FORGINGS

TO DIESEL CRANKSHAFTS

WEIGHING UP TO 4000 LBS.

THE PARK DROP FORGE CO.

Gordon Park at E. 79th. Cleveland 3, Ohio

Obituaries

Continued from Page 95

and chief engineer of Fowler Refrigerating Machine Corp., Baltimore; and a captain in the U. S. Army during World War I.

Fowler's specialty was invention, design, and development of new devices for aircraft, automotive, and marine use. He obtained the Bachelor of Science degree in Mechanical Engineering from the Georgia School of Technology in 1906. He had also taken courses at Columbia University and the Massachusetts Institute of Technology. He received his preparatory education at the Mt. Pleasant Military Academy, Ossining, N. Y. where he graduated with honors. One of his interests in later years was tutoring young engineers in higher mathematics.

IRVEN E. COFFEY

Irven E. Coffey, new products engineer of Carter Carburetor Corp., St. Louis, Mo., died Sept. 23. He had been associated with Carter for over 22 years.

Coffey was the inventor of the most widely used current automatic choke on carburetors today. He was also responsible for most of the development of the present Carter Mechanical Fuel Pump and the Carter car starter switch on the carburetor. He held numerous patents in both the mechanical and electrical field.

In his early days he operated his own business in the middle west and California, rebuilding batteries and starting systems for many of the early automobiles.

Coffey was born in Vienna, Mo. in 1888. He was a member of the SAE since 1940.

FRED G. FOLBERTH

Fred G. Folberth, Automotive Development Co., Cleveland, died September 22. He had been a member of SAE since 1925.

At the time he joined the society, he was president of the Folberth Auto Specialty Co. in Cleveland. He had headed that organization since 1910. Previously he had been with Olds Motor Works, Lansing, Mich., as traveling expert and prior to that with the B. F. Stearns Co. in charge of floor work (assembling of automobiles).

He was a designer of carburetors and various other automobile parts as well as accessories. Although he did not have the advantage of college training, he was considered a man of exceptional ability along inventive and engineering lines. He was a member of several societies and clubs in Cleveland.

A naturalized citizen of the United States, Folberth had been born at Mediasch, Transylvania.

J. D. MOONEY

J. D. Mooney, president for fifty years of Auto Engine Works, Inc., St. Paul, died recently.

As a young man, Mooney had worked as machine shop foreman for the Great Northern Railroad Co. Then, when he was 27, he became general manager and president of Auto Engine Works in St. Paul. He designed and had patented the "Capitol" reverse gear.

He became an SAE member in 1945. Although he did not have formal schooling in automotive subjects, he had had forty years practical experience in internal combustion engineering, mechanical engineering, and gear work. He was also a member of the American Society for Metals.

AL ERHART

Al Erhart, superintendent, Motor Transport Department, City of Hamilton, Ohio, Municipal Garage, died Sept. 22.

He started in the automotive industry as an errand boy and parts chaser during school vacations. In 1922 he took a full time job as mechanic with the Frand Ratz Garage, Hamilton, Ohio.

For the past 25 years, Erhart had been employed by the City of Hamilton as master mechanic and superintendent of garage and motor equipment. He had direct supervision over all motor equipment maintenance, repair, operation, and the writing of the specifications for this motor equipment for the city.

G. VAN TWIST

G. van Twist, president of the Board for Technical Education, Dutch Automobile Trade & Industry, 's-Gravenhage, Holland, died Sept. 12.

He was a foreign member of SAE, born and living in Dordrecht, Holland. He was also a member of Societe des Ingenieurs de l'Automobile, Paris.

After completing technical school, studying civil engineering, he entered the firm of N. V. van Twist as managing director in charge of the technical service. He then served in the Royal Dutch Army in technical education of Army mechanics.

He continued educating as chairman of the Commission for Technical Education of Automobile Mechanics of the Dutch Association of Garage Owners. He was also co-author of many books of technical nature on automotive products.

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Tobacco Production Needs Mechanization

Based on paper by

WILLIAM E. SPLINTER

CHARLES W. SUGGS

Agricultural Engineering Department
North Carolina State College

and

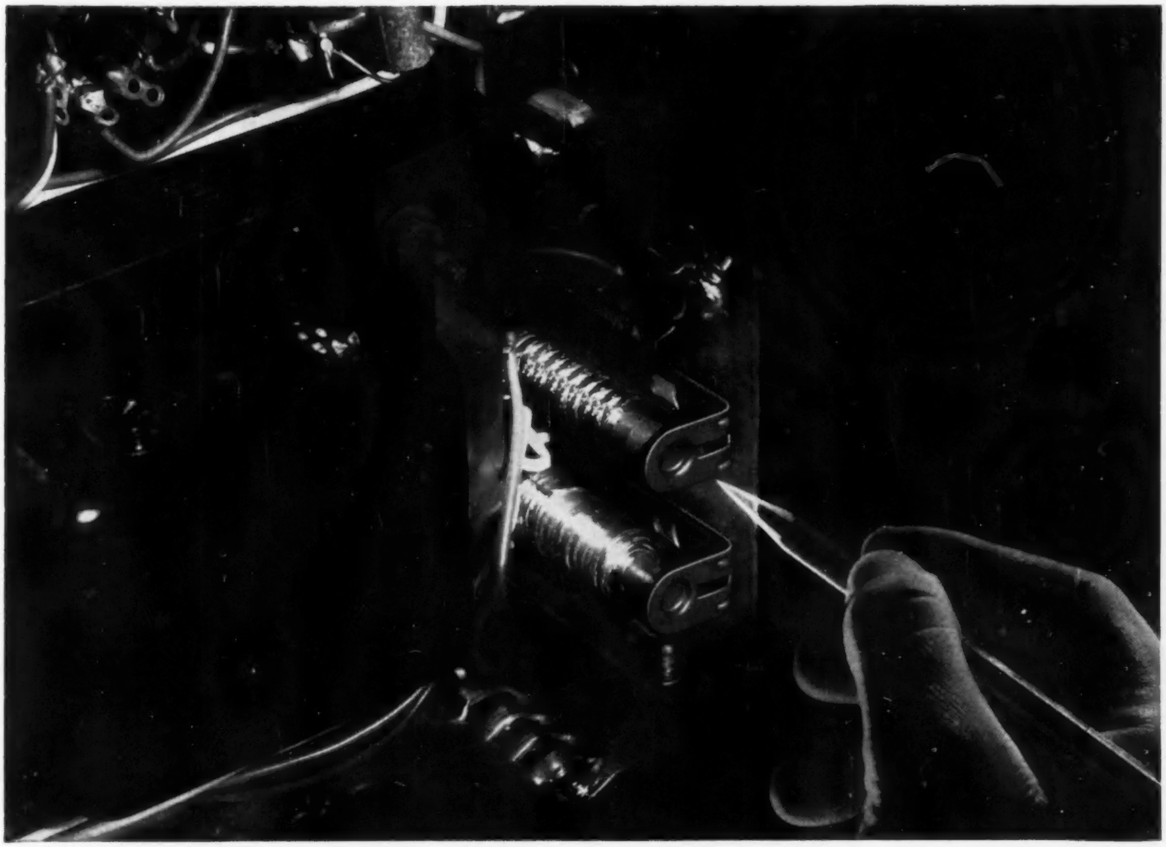
ROBERT W. WILSON

R. H. Bouligny Co.

TOBACCO is one of the few major crops in which cultural practices have not yet been mechanized. Yet certain operations could be mechanized for time saving. Use of a mechanical transplanter will allow two men to set four to five times as many acres of tobacco as they could with a conventional hand setter, in any given period of time. Proper use of a rotary hoe can reduce the cultivation and hoeing labor by 75%. Through the use of a mechanical topper and oil emulsion applicator, labor for topping and suckering may be reduced by 80%.

Harvesting is the bottleneck in production and here is where mechanization is most needed. Several machines are in the developmental stage, the work being done mainly by farmer-inventors. But many problems remain to be solved before complete development of a mechanical harvester can be realized. The leaves must be picked up, preferably before coming in contact with the ground, and conveyed to a mechanism which will automatically arrange them for curing. There are several avenues of approach—one is to develop an automatic looping device; another is to sew or affix the leaves to a continuous strip or belt, or to use clamping sticks to grip the tobacco. Research in curing suggests the possibility of by-passing the need for looping and sticks which would mean curing and drying the tobacco in bulk.

When compared with the development of the grain combine, we would place the present commercial tobacco machines on the level of the reaper which was being marketed in the 1830's. It remains to be seen whether development will be as slow as it was with other agricultural machines like the corn picker, cotton picker, combine, and baler, or will take advantage of technological advances to mature quickly. (Paper "Mechanizing the Production of Tobacco" was presented at SAE Golden Anniversary Tractor Meeting, Milwaukee, Sept. 15, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)



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The Westinghouse Television-Radio Division, Metuchen, New Jersey, needed a fastener to fill a complex fastening requirement. Tinnerman was consulted, and developed a *special* SPEED CLIP that fit the job perfectly!

This one-piece, spring steel SPEED CLIP is assembled quickly and easily to the television tuning coil. The SPEED CLIP, with tuning coil attached, is then simply snapped by hand into twin mounting holes in the chassis to lock the unit securely in place. This SPEED CLIP cuts costs on the assembly line. And it permits fast and simple adjustment of the television tuning coils, eliminating the problem of blindly searching with a screw driver for the slot of a special hex nut.

Find out how SPEED NUT Brand Fasteners can help you improve your own fastening methods. Ask your Tinnerman representative for details of our Fastening Analysis Service or write for Bulletin No. 336.

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Canada: Dominion Fasteners, Ltd., Hamilton, Ontario. *Great Britain:* Simmonds Aerocessories, Ltd., Treforest, Wales. *France:* Aerocessoires Simmonds, S. A., 7 rue Henri Barbusse, Levallois, (Seine). *Germany:* Hans Sickinger GmbH "MECANO", Lemgo-i-Lippe.

TINNERMAN Speed Nuts® FASTEST THING IN FASTENINGS®

Laboratory control over new premix compounds provides GREATER UNIFORMITY OF STRENGTH in Fabricon-molded reinforced plastic parts!

Ever considered the use of reinforced plastic molded parts to *improve* the quality of your product and *reduce* manufacturing costs, too? If so, you'll be *doubly* interested in this latest development from Fabricon. For as pioneers in "gunk molding" of premix compounds, Fabricon chemists and process engineers have been well aware of the lack of uniformity commonly encountered in many such molded parts. That's why, during the past 5-years, they've made it their business to find ways and means of overcoming this obvious limitation. By the selection of proper basic materials to meet specific application requirements. And, too, by the development of special laboratory controlled processing techniques which assure consistent quality in the volume production of intricate, complex parts. As a result, Fabricon's new premix plastic moldings now possess far greater uniformity of strength than heretofore thought possible . . . plus a host of other desirable properties which highly recommend their use on countless different products, *yours included!*

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PHYSICAL CHARACTERISTICS	PREMIX COMPOUND	
	MP-155 (Sisal)	MP-182 (Glass)
Flexural Strength, psi	11,200–13,400	14,800–19,300
Modulus of Elasticity in flexure—10^6 psi	1.17 – 1.40	1.20 – 1.72
Izod Impact Strength, foot-pounds/inch of notch	4.2 – 5.4	6.3 – 8.3
Water Absorption, % 24 hr.	1.78 Average	0.05 Average
Heat Distortion Temp.	302°F. (+)	302°F. (+)

Above values based upon tests conducted by independent laboratories in accordance with ASTM methods. Compounds listed are latest of over 150 grades developed and produced by Fabricon. Sample test panels gladly furnished upon request.

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New Members Qualified

These applicants qualified for admission to the Society between Nov. 10, 1955 and Dec. 10, 1955. Grades of membership are: (M) Member; (A) Associate; (J) Junior.

Atlanta Section

Arthur Leo Corcoran, Jr. (J).

Buffalo Section

Roy W. DeWitte (J), Merle R. Wilson (J).

Central Illinois Section

Ralph W. Ferre (J), Joseph T. Gregorich (M), Robert E. Woodcock (J).

Chicago Section

John E. Bacon (J), Harris E. Dark (A), Arthur E. Evenson (J), Roger Royall Gay (J), E. W. Lapp (M), Carl J. Oldenburg (A), LeRoy W. Randt (M), Raymond A. Schakel, Jr. (J), Gunter W. Schwandt (M).

Cincinnati Section

Mathew David Garred, Jr. (J).

Cleveland Section

William H. Denton (M), Edward James Dixon (A), Robert B. Miller (J), James T. Morrison (J), William W. Peters (M), Warren D. Waldron (J).

Dayton Section

Walter G. Kniffin, Jr. (A), Glenn A. Midkiff (J).

Detroit Section

George J. Adams (M), Hulki Aldikacti (J), Arthur B. Bailey (J), Calvin E. Bamford (M), Alfred D. Bosley, Jr. (J), Robert B. Boswell (M), John M. Downing (J), Thomas Leo Geiger (J), William J. Herrmann (M), Frank R. Holliday (M), Glenn M. Jones (M), Robert J. Lechner (J), Ervin C. Lentz, Jr. (J), Warren J. Lotz (J), Murdoch J. MacKenzie (M), Alex D. MacMillan, Jr. (J), John Evans McDonald (J), Harvey E. Miller (J), Willard A. Murray (M), James H. Orrick (J), G. B. D. Peterson (A), Carl B. Pfeiffer (M), William J. Richardson (J), Robert S. Siegler (J), Frank S. Staron (M), George E. Wise (M).

Hawaii Section

Clifford D. Yancey (M).

Indiana Section

Ralph Bancroft-Billings (J), Harry W. Grinstead (M), C. A. Kenninger (M), Robert B. Kurre (M), A. Merril Morris (M), Robert W. Sewall (J).

Kansas City Section

Cyrus F. Wood (M).

Lockheed diversification in action...

At right: engineers and scientists work on some of the 46 major projects in progress at Lockheed

Operations Research discussion on continental defense

Operations Research openings

Electronics Specialists
Fire Control and Guidance Specialists
Aerodynamics Engineers
Physicists

Fatigue test on Super Constellation skin

Structural Engineering openings

Research Specialists
Structures Engineers
Stress Analysts
Weight Engineers

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because there are more supervisory positions to be filled with 46 major projects underway, including 13 models of aircraft on assembly lines.

2. More career security
because Lockheed activities cover virtually the entire spectrum of aeronautical endeavor.

3. Life in Southern California
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Design positions are open at all levels in controls, electrical, hydraulics, mechanical, power plant and structures fields.

IBM 701 applied to jet transport flutter problem

Math. Analysis openings

Math. Engineers
Math. Specialists
Math. Analysts

In-flight test on air speed performance

Flight Test Engineering openings

Flight Test Engineers
Flight Test Analysts
Instrumentation Engineers
Electrical Research Engineers

Aerodynamic meeting on high-speed fighter

Aerodynamics openings

Aerodynamics Engineers
Aerodynamicists
Dynamics Engineers
Wind Tunnel Test Engineers

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New Members Qualified

continued

Metropolitan Section

Bruce C. Barnes (J), Irving T. Bartlett, Jr. (M), Stanley Benerofe (J), Edward W. Bradley (M), Ronald L. Farrar (J), Arnold Fink (J), Melvyn Lane Henkin (J), Joseph A. Horvath (J), A. Vincent Maisoneuve (A), Sol Mendelson (J), James P. Moreland (M), John G. Pohl, Jr. (M), Donald V. Sarbach (M), Lawrence K. Wartell (J).

Mid-Continent Section

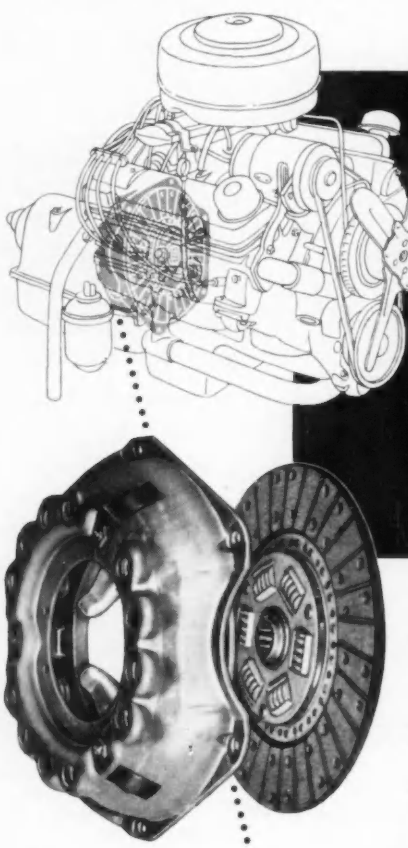
C. Converse Grimshaw (M), A. F. Love, Jr. (A), George D. McLean (M), A. J. Snyder (M).

Mid-Michigan Section

R. James Benner (J).

Milwaukee Section

Kenneth L. Morgan (A), Russell K. Sesto (M).



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Chicago 38, Illinois

Montreal Section

Gerard Daigneault (J), James Rankin (A).

New England Section

John D. Morrison (M), Paul John Williams (J).

Northern California Section

Efton Kump (A), Robert LeRoy Pohl (J).

Northwest Section

Kenneth Francis Emerson (J), Fred H. Heiberg (A), Richard W. Montague (J), Emerson F. Reiber (J).

Oregon Section

Dewey H. Campbell (M).

Philadelphia Section

Robert N. Brower (J), Howard C. Freeman (A), A. J. Holt (M), Lubomyr Kociuba (J), William R. Miller (M), Richard R. Pruyn (J), Oliver E. Spencer (J), Stanley S. Wulc (M).

Pittsburgh Section

Howard M. Bernbaum (J), Philip S. Marinkovich (J).

St. Louis Section

Earl F. Hubacker, Jr. (J), Kenneth C. Kahre (J), Frank E. Pipe (M), John A. Szabo (J).

San Diego Section

Milburn C. Copold (M), Andrew J. Edwards (J).

Southern California Section

Emiel T. Bouckaert (J), William G. Brown (A), Norbert Donald Brule (J), John H. Camlin (J), Edwin H. Charles (J), Allen R. Eberle (J), Donald E. Eddy (J), Kenneth G. Ferrel (J), Merle Alan Fillmore (A), James E. Fink (J), William F. Gresham (M), Robert J. Hopkins, Jr. (J), Arthur J. Koski (J), Fred Elmer Nelson (J), Robert Leo O'Loughlin (J), J. Bruce Ramsey (J), Jack D. Rigby (M), Harold W. Seyle (M), Joseph Henry Shirar (A), Don G. Smith (A), William L. Sparks (M), Paul L. Sweeney (J), Charles S. Wagner (M), George F. Weinwurm (J).

Southern New England Section

Willard W. Bunnell (J), H. Clark Island (J), William R. Johnson (M), Robert W. Martin (J).

Texas Section

Charles K. Cates (A), Edwin F. Thomas (M), Al C. White (A).

Texas Gulf Coast Section

Herbert P. Ferris (A), W. H. Heesche (M).

Twin City Section

Paul S. Petersen (J).

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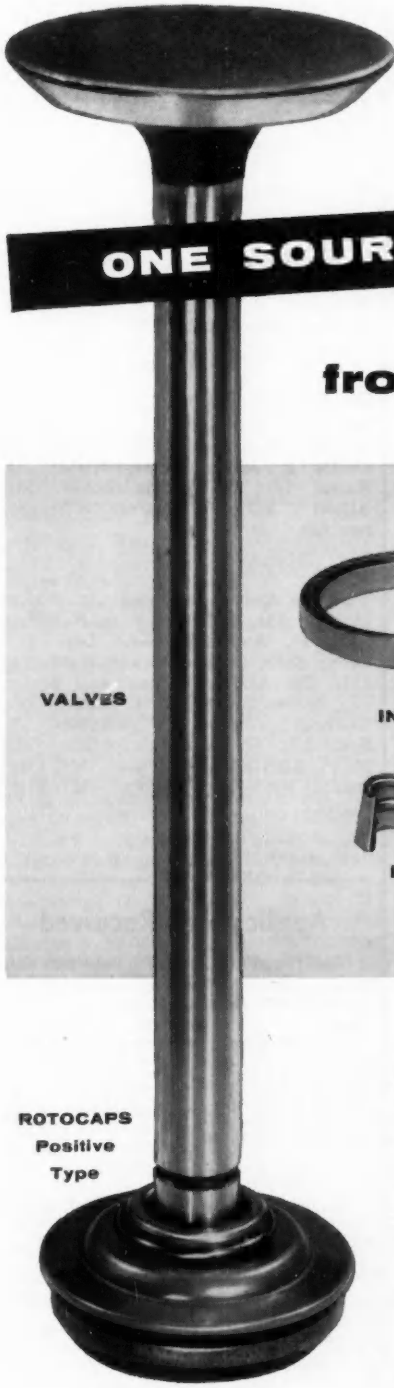

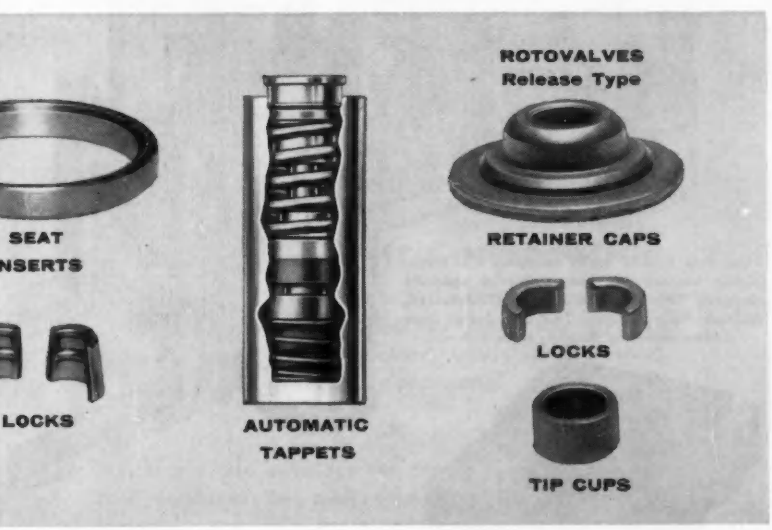

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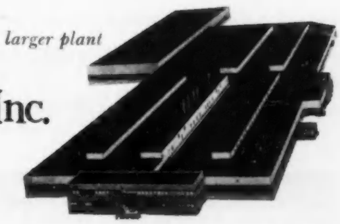

Valve Division Thompson Products, Inc.

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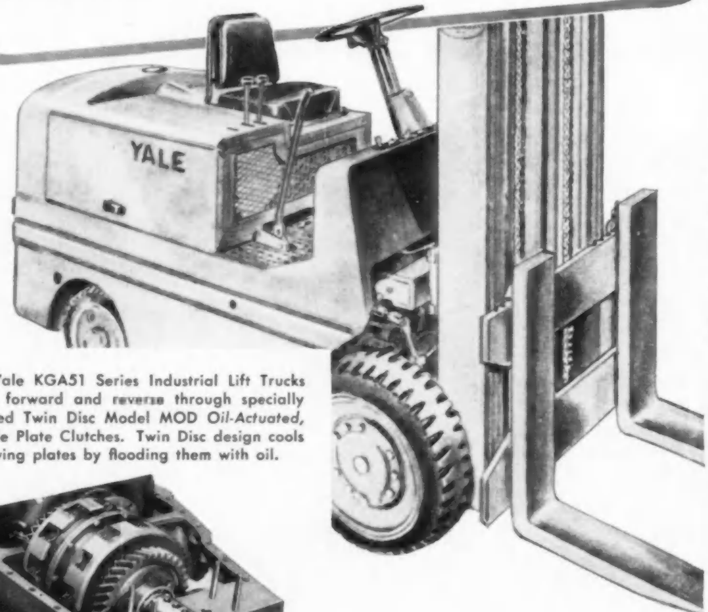
Forward and reverse on new Yale KGA51 Series obtained by specially designed *TWIN DISC CLUTCHES*



New Yale KGA51 Series Industrial Lift Trucks obtain forward and reverse through specially designed Twin Disc Model MOD *Oil-Actuated,* Multiple Plate Clutches. Twin Disc design cools driving plates by flooding them with oil.

The fully automatic transmissions in the new Yale KGA51 Series Industrial Lift Trucks obtain forward and reverse motion through specially designed Twin Disc Model MOD *Oil-Actuated,* Multiple Plate Clutches.

Because of the severe energy cycle of the vehicle, a specific clutch for finger-tip control was required. Twin Disc Engineers *worked closely* with the manufacturer in developing such a clutch. In the special Twin Disc design, oil is pumped through the shaft and cools the driving plates *by flooding them with oil.* Sintered friction material is also used, because of the high energy loading.

If you have a specific power linkage problem, on your powered equipment, consult Twin Disc Specialists . . . ask them to assign you a project engineer. Twin Disc Clutch Company, Racine, Wisconsin.

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New Members Qualified

continued

Virginia Section

Earlie S. Everhart, Jr. (J), Joseph William Sickinger (A).

Washington Section

John Henry McCoy (J), Carl C. Sorgen (M).

Wichita Section

J. M. Tucker (M).

Outside Section Territory

Victor H. Boettcher, Jr. (A), William E. Coman (J), Kenneth W. Domier (J), Curtis E. Johnson (J), Wilbert G. Kautz (M), W. Eugene Sinner (M), Alfred T. Sutter (J), James O. Troemner (J).

Foreign

James Alcock (A), England; Pieter Drayer (M), Holland; John Hamilton Lee (J), Australia; José Levy (J), Peru; John Lamb Blackwood Murray (M), So. Africa; Jorgen Aall Myhre (J), Norway; Malcolm J. Nunney (J), England; Donald C. Paterson (J), Scotland; Giovanni Savonuzzi (M), Italy; Karl-Heinz Schmidt (M), Germany; Werner K. Strobel (M), Germany.

Applications Received

The applications for membership received between Nov. 10, 1955 and Dec. 10, 1955 are listed below.

Alberta Group

W. H. Hannam, George A. C. Higgs, Lloyd O. Lundquist.

Atlanta Section

Jarma E. Dixon, Jr., George T. Hicks, Willie J. (Jack) Kile.

Baltimore Section

John N. Schweikert, Harry J. Stubbs.

British Columbia Section

J. Ross Lint.

Buffalo Section

John D. Hopkins, Donald W. Langdon.

Canadian Section

George E. Bausor, Francesco G. Bonmartini, Raymond J. Lambert, Melvin G. Sandell, Kenneth B. Young.

Central Illinois Section

Norman R. Abernathy, Melvin W.

Applications Received

continued

Demmin, Joe Rush Jones, William H. Springer, James Patrick Welsh.

Chicago Section

Donald A. Denniston, Martin T. Dyke, John W. Ferguson, James M. Hutchinson, W. Gordon Jarvis, John R. LeVally, Jr., Robert F. Prihar, R. J. Siewers, Robert J. Smith.

Cleveland Section

Robert H. Braun, H. H. Deist, James E. Murphy, Louis J. Stankiewicz, Louis J. Sykora.

Colorado Group

Frank J. Kunde.

Dayton Section

J. Edward Ashworth, Chester W. Holmes, Paul R. Hughes.

Detroit Section

J. Milton Agar, H. A. C. Anderson, Robert J. Bailey, Walter J. Barbish, Harry M. Buckingham, William S. Carter, Aldo Ceresa, Roderick Craves, A. B. Curtis, Robert E. Dale, Frank J. Falk, William J. Freyermuth, Alexander Georgeff, Jr., Clarke D. Glasow, Richard J. Gould, Alvin T. Hanson, Jr., Clinton F. Hegg, Robert L. Hensel, Earl W. Jorgensen, Wade R. Marett, Horton Matthews, C. T. McClure, Robert D. Montgomery, Louis F. Mortenson, George A. Nahstoll, Jr., Charles Nielsen, Jr., Howard W. Noble, Ferdinand C. Pringnitz, Robert A. Rasmussen, Clyde ("Bud") Reeme, Casimir S. Rejent, Jr., James Robinson, J. B. Rohrer, Calvin J. Sandberg, Frederick Schwartz, H. Clare Shepard, John G. Soroka, Frank R. Spiaser, Warren C. Steele. Raymond Stevens, C. M. Stordahl, Jr., Arthur F. Sullivan, James Thornton, Howard B. Tranum, John L. Walker, F. Roderick West, Daniel J. P. Zink.

Hawaii Section

Homer W. Widener, Jr.

Indiana Section

Clyde S. Berry, Herbert L. Porter, David C. Shropshire, Jr.

Kansas City Section

D. Robert Brown, Harold L. Hildestad, John M. Van Dam.

Metropolitan Section

Carl A. Carlsen, Charles J. Casaleggi, Joseph G. Costigan, William D. Dilday, Joseph D. Early, Edward S. Epp, Thomas R. Evans, Herbert L. Forman, Clarence E. Irion, Jr., Lauren L. McMaster, Milton E. Murdock, Richard E. Nelson, William Nittel, Thomas L O'Brien, John W. Partridge, Lionel E. Reed, Harry L. Richardson, Wilfred C. Rippe, Jr., John L. Sullivan, Jr., Charles Wilde.

Mid-Continent Section

J. E. Donnelly.

Mid-Michigan Section

Forrest S. Fisher, Arnold G. Kruse, Arthur L. Ott, Jr., John H. Ruthig, Harold R. Seymour, William J. Weber.

Milwaukee Section

Donald A. Henrich, J. W. Jaspersen, Max R. North, Alpheus Stevenson, H. Louis White.

Montreal Section

Roger Bussieres, Richard F. Critchley, Arnold A. Rackham.

New England Section

John P. Purcell, Richard F. Shannon, C. O. Sparhawk.

Northern California Section

Donald W. Behrens.

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Newly formed Rex division has immediate openings for Turbomachinery Specialists—unusually interesting, unusually promising.

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If you are qualified by experience, are eligible for secret clearance, and are interested in any of the following categories in design, development or drafting, please write for further information to: Robert L. Ehinger, Rex Division, 9851 So. Sepulveda Boulevard, Los Angeles 45, California.

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SAVE TIME!
SAVE TROUBLE!
SAVE MONEY!

If you've got a product involving metal fabricating, fastening or assembling, chances are you can use Midland Welding Nuts to big advantage.

They come in all sizes for every-sized job. Welded to the part or parts concerned, they don't have to be held while bolts are turned into them. Thus one man can often do the work of two.

And they're indispensable when it comes to those tucked away, hard-to-get-at places. Welded in advance to those inside spots where it is difficult—or *impossible*—for hands or tools to reach, Midland Welding Nuts hold fast while bolts are turned into them.

If you're a designer, you'll want to know about these time and labor-savers, too. Midland Welding Nuts will solve and simplify many of *your* problems, too.

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Applications Received

continued

Northwest Section

Robert B. Cheminant.

Oregon Section

William H. Ferguson.

Philadelphia Section

Otto E. Parkkonon, Joseph J. Zaiss.

Pittsburgh Section

Lewis U. Davis, Donald R. O'Malley.

Salt Lake Group

William W. Graham, Robert W. Olin.

San Diego Section

Arthur J. Quinlan, Paul H. Whitmoyer.

Southern California Section

R. H. Bartels, Clarence L. Crawford, Ralph W. Moss, Glen Moy, L. Eugene Root.

Southern New England Section

William R. Hamilton, Jr.

Texas Section

Leslie S. Dame, William C. Howard, Robert H. Jay, Merril V. Riccius.

Texas Gulf Coast Section

Edgar Irvin Ballard, William S. Dixon, Roy H. Finefrock, Norman P. Geiken, Jack W. Richardson, Philip C. White.

Twin City Section

Hendrie J. Grant.

Washington Section

James K. Knaell, Frank C. Schwager, Alfred van der Hoeden.

Western Michigan Section

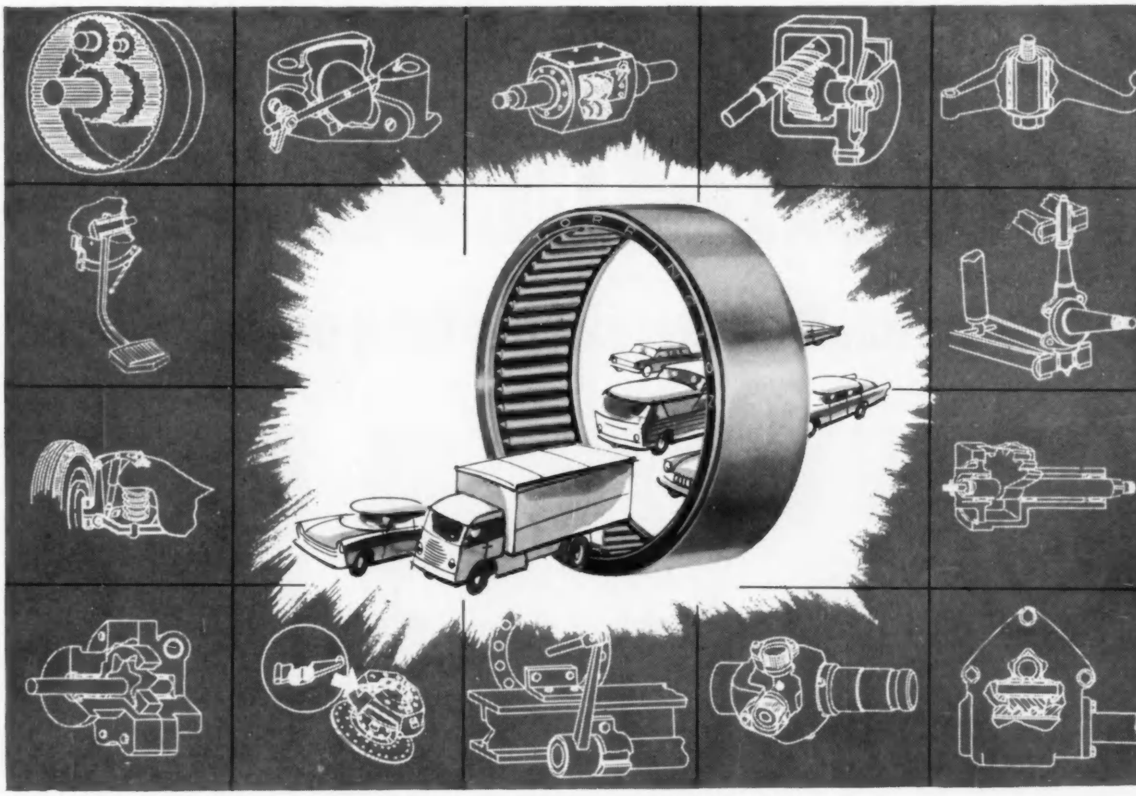
Raymond C. Kleber, Teaphel A. McMahon.

Outside of Section Territory

Richard S. Cook, Jr., William M. Elam, Benjamin G. Gray, Charles W. Haagen, Harold K. Kienzle, James C. Malone, Jr., William R. McCann, Howard A. McCutcheon, John R. Shively, Hubert D. Songer, Edward Stachel, Roger A. Stalter, W. C. Truckenmiller, Paul R. Welch, Francis I. Willett.

Foreign

George A. Brander, S. Rhodesia; Hector N. Fernandez, Argentina; Brian Caldicott, England; John Derick Hopkins, England; Rudolf O. Hoss, Germany; John G. Masilamani, India; Yachamaneni Rama Rao, India; Madhukar V. Vaidya, India; Marcel G. Wachtel, Netherlands; Adolf Josef Wuensche, Germany.



TORRINGTON NEEDLE BEARINGS offer the Automotive Manufacturer these advantages

1. High capacity
2. Small size
3. Low cost
4. Ease of installation
5. Long service life

The automotive industry was one of the first to see the unique advantages of the Torrington Needle Bearing when it was introduced nearly twenty years ago. Today, leading manufacturers of automobiles, trucks and components have standardized on the Needle Bearing to such an extent that it is in use in almost every rotating or oscillating bearing application where compactness, high capacity and ease of installation are important.

The NEEDLE BEARING has been "Performance Proved" in these Major Applications

Universal joints • Governors • Steering gear rollers Steering knuckles • Steering idlers • Power steering Suspensions • Brake camshafts • Brake and clutch linkage pivots • Clutch throw out fingers • Transmissions • Hydraulic pumps • Window lifts *and many others.*

If some of these applications of the Needle Bearing are new to you, why not let our Engineering Department show you how they can improve the design and performance on your product? See your Torrington Bearing representative or write direct.

THE TORRINGTON COMPANY
Torrington, Conn. • South Bend 21, Ind.

District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON BEARINGS

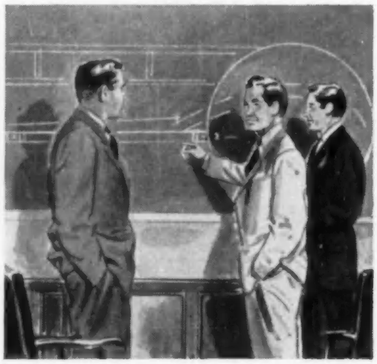
THE TORRINGTON COMPANY 90th ANNIVERSARY 1866–1956

Needle • Spherical Roller • Tapered Roller • Cylindrical Roller • Ball • Needle Rollers

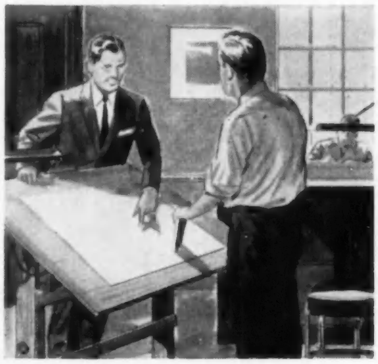
SPICER SPECIALIZES

..*follow-through* on every detail from original "thinking

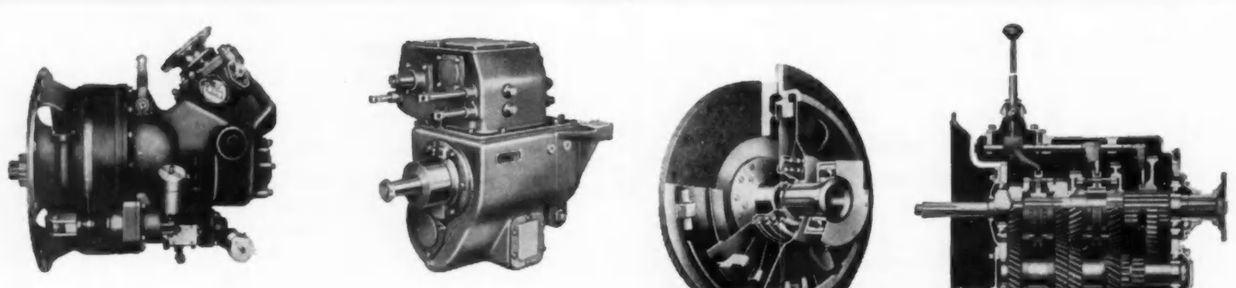
We are there . . . on the job . . . when to-morrow's new car plans and projects are still in the "doodle and discussion" stage.

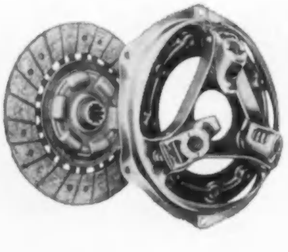


We are there . . . on the job . . . when the first mechanical layouts illustrate complex power transmission requirements as re-lated to new body, chassis, engine and wheel suspension designs.



We are there : . . on the job . . . when Spicer product engineers translate car manufacturers' "problems on paper" into factors that can be solved by Spicer know-how and product versatility



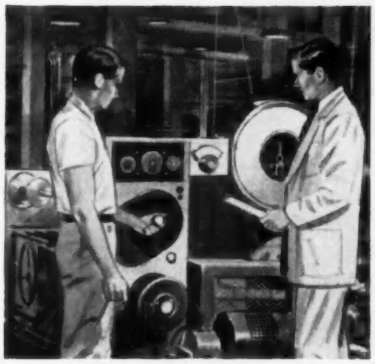


Spicer

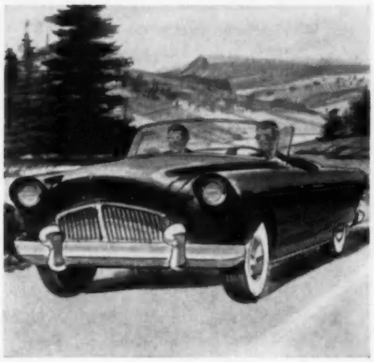
DANA

IN FOLLOW-THROUGH

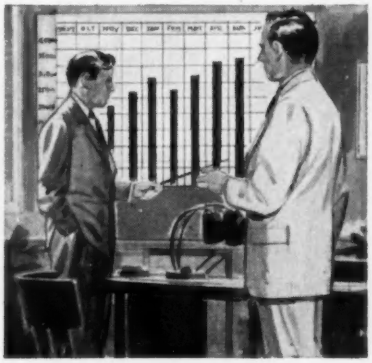
for tomorrow" to prompt delivery of finished product



We are there . . . on the job . . . when new Spicer product developments are tested by the industry's most advanced electronic and mechanical laboratory testing equipment.



We are there . . . on the job . . . when the customer's most punishing road tests check the correctness of Spicer design and manufacture.



We are there . . . on the job . . . with product shipping schedules completely coordinated with the customer's anticipated monthly output.

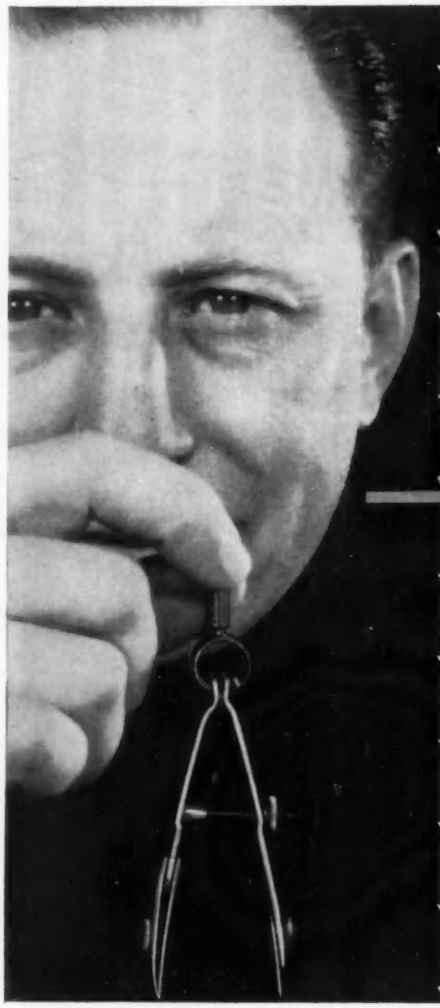
Spicer service is complete and comprehensive. It creates . . . designs . . . engineers . . . manufactures. And keeps a sharp "follow-through" eye on the progress of each individual job through every step right to customer assembly lines.

Spicer service has been continuous to the automotive industry for over 50 years. Each year sees major power transmission developments which Spicer has created . . . designed . . . engineered . . . and manufactured. These advancements were months and years in their transition to practical use. The new designs we are working on today will be delivered as finished products, one . . . two . . . and three years hence, on schedule, and in keeping with the reputation of Spicer units as "The Standard of the Industry."

No matter what type of automotive vehicle you make . . . no matter what type of power transmission design you need . . . Spicer engineers and Dana resources can serve you well.

CORPORATION • TOLEDO 1, OHIO

SPICER PRODUCTS: TRANSMISSIONS • UNIVERSAL JOINTS • PROPELLER SHAFTS • AXLES • TORQUE CONVERTERS • GEAR BOXES • POWER TAKE-OFFS • POWER TAKE-OFF JOINTS • RAIL CAR DRIVES • RAILWAY GENERATOR DRIVES • STAMPINGS • SPICER and AUBURN CLUTCHES • PARISH FRAMES



Whatever the

DESIGN...

we can make it

WATER-TIGHT!

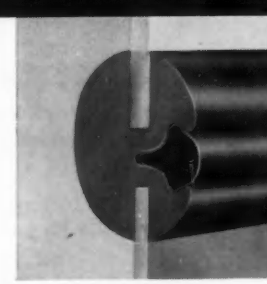
Inland Self-Sealing Weather Strip—with the magic Filler Strip—simplifies the design job . . . makes the job of on-the-road or in-the-shop replacement fast, easy, positive. Gives new design freedom, too. The versatility of Inland Weather Strip means windows of any size, any shape can be quickly fitted with a positive seal against **any** moisture. The Filler Strip puts that needed pressure where it counts—**on the fence and the glass!**

Installation of Inland Weather Strip is a one-man job. It can be done in the shop or on the road—quickly, easily. No cement, clamps or binders . . . no need to plan intricate, expensive mounting surfaces, channels or moldings. Pocket the savings you realize on lower installation costs . . . or apply it to other features you'd like incorporated in your project.

INLAND

self-sealing weather strip

(PATENTED)



INLAND MANUFACTURING DIVISION
General Motors Corporation, Dayton, Ohio

a part of the General Motors Master Plan for Greater Highway Safety through Better Engineered Products!

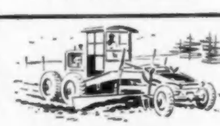
THEY designed 'em... WE made 'em water-tight!

Transportation Industry

Automotive Installations

Railway Equipment

Marine Applications



Over-the-road Equipment

Commercial Structures

Send for Free Print—1900 De Dion-Bouton Motorette.
This print from the file of P. S. de Beaumont, not for commercial use.

The De Dion-Bouton is remembered today for the De Dion axle, a frame that contained the differential, which more recently many racing and sports car models have adopted. This model also employed a one-cylinder engine mounted in the rear with automatic intake valve. This is one of a series of antique automobile prints that will appear in future Morse advertisements. Write for your free copy, suitable for framing, to: MorseChainCompany,Ithaca,NewYork.

Why Morse Timing Chains are original equipment on 13 out of 17 automobiles

Thirteen of the seventeen automobile manufacturers who now use timing chain drives as original equipment, specify Morse Timing Chain Drives. This is true for several reasons:

(1) Morse Timing Chain Drives assure car, bus, and truck manufacturers of long, trouble-free service life—eliminate maintenance difficulties. (2) Morse Timing Chain Drives offer safe, quiet, and smooth operation, even when camshafts and crankshafts are not exactly parallel. (3) Speedy delivery of a complete line of timing chain drives helps to meet production schedules. (4) Morse offers expert engineering service to assist in solving automotive timing chain problems of design, development, and application.

Check with Morse on your timing chain problems. Find out, too, how well other Morse Power Transmission Products can answer your needs in product design and application. MORSE CHAIN COMPANY, ITHACA, NEW YORK.

MORSE BW **CHAINS, CLUTCHES, AND COUPLINGS**

Spot, Plug, and Tack-Weld

with the new **SIGMA SPOT-WELDING** *process*

- **Joins metals up to ¼-in. thick**
- **Adds filler metal automatically**
- **Welds from one side of the joint**
- **Shields weld area with inert argon gas**
- **Operates on Constant Potential power supply**

Spot, plug, and tack-weld with one torch. With sigma spot-welding you can make strong spot welds quickly on lapping metal sheets up to ⅛-in. thick, plug and tack-welds on metals up to ¼-in. thick—and you need access to only one side of the weld joint. Use it on carbon, galvanized, or stainless steel, and copper-base alloys.

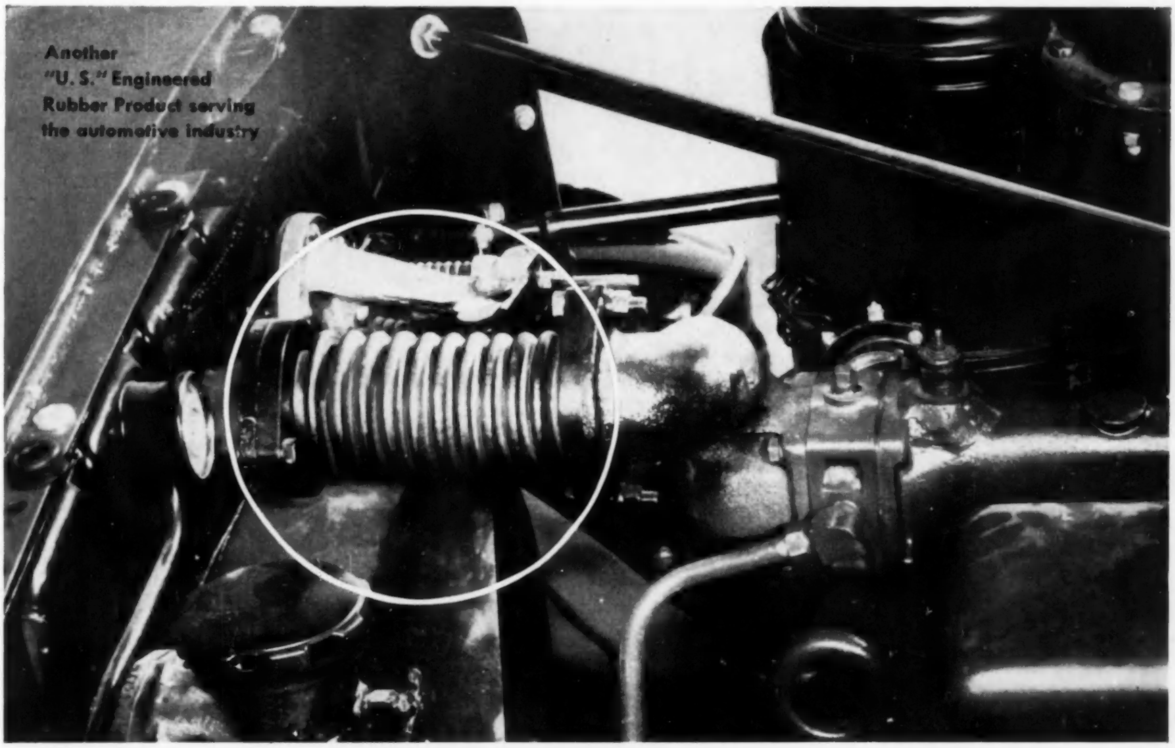
It's easy to use. Position the "muzzle" of the water-cooled torch and squeeze the trigger—the machine does the rest. A consumable wire electrode is fed into the weld area as filler metal. Inert argon gas protects the weld from the air. You can make up to 10 welds a minute, with a completely automatic welding cycle.

Constant Potential adds to efficiency. Sigma spot-welding equipment operates on constant potential power supply to give you the benefit of simplified controls, sure starting, and precise arc voltage. Weld-cratering and wire-sticking are eliminated. Welds are smooth and consistently uniform.

Your local LINDE representative will be pleased to give you booklet F-8778 and more detailed information on the sigma spot-welding process.

Linde Air Products Company
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street UCC New York 17, N. Y.
Offices in Other Principal Cities
In Canada: LINDE AIR PRODUCTS COMPANY
Division of Union Carbide Canada Limited, Toronto
(formerly Dominion Oxygen Company)

Linde
Trade-Mark



Have YOUR hose and connections the "GIVE" it takes?

U. S. MULTI-FLEX "gives" movement in extension and compression—indefinitely!

Multi-Flex® has proved its superiority for a wide number of applications, including radiators, carburetor air intakes, boots for hydraulic pistons, shock absorbers, worm gears and sensitive adjusting screws, exhaust outlets for garages, and hundreds more.

For example, as a connection between the cast tubular line from the radiator and the engine tubular line, U. S. Multi-Flex provides *flexibility,* allows the engine to move without transmitting force, both laterally and fore and aft on the radiator. Unlike Multi-Flex, a rigid piece of hose would exert a high degree of leverage force on the radiator and the radiator tank. Multi-Flex is available with flanges at either end; it also can be fastened in the conventional manner with clamps.

Since it's made without molds, special mandrels, or supporting wires, natural or synthetic rubber Multi-Flex can be fabric-reinforced, too—produced in inside diameters all the way from ⅛" to 36", in lengths unlimited. And one special Multi-Flex formulation withstands temperatures from –65°F to 500°F! Unlike wire supported hose, it can be crushed repeatedly without harm.

The extensibility of Multi-Flex makes short lengths practical; its ease of application (with slip-over nipple or flange connectors) saves assembly line time. For *"all-ways"* flexibility—for the greatest travel with the least fatigue—for *economy* and *long life,* you'll find you just can't match Multi-Flex.

Most samples for experimental use can be made without tooling charges. In Detroit, phone us at Trinity 4-3500 or write us at New Center Bldg., Detroit 2. It's your contact with *specialists* in automotive rubber applications.

US RUBBER

Mechanical Goods Division

United States Rubber

"How do you know when an engine needs attention?"

...you get the Complete Answer from the built-in

VEEDER-ROOT

Rev-Counter

These rugged counters record the shaft-revolutions of engines, generators, compressors, heaters and other equipment. So you *and your customers* can see at a glance how your equipment is holding up to its guarantee . . . whether it needs replacement parts . . . when routine maintenance is coming due.

That's why it pays, in designing engines of any type, to build-in the genuine Veeder-Root Rev-Counter as a standard integral part . . . as has been done for many years by leading builders of tractors and aircraft.

Take note, too, that this counter is available with *tachometer take-off* . . . and that it may be furnished geared to any engine rpm. So build up your sales . . . build the Veeder-Root *Rev-Counter* into *your* product. Write:

Everyone can Count on...

VEEDER-ROOT

The Name that Counts

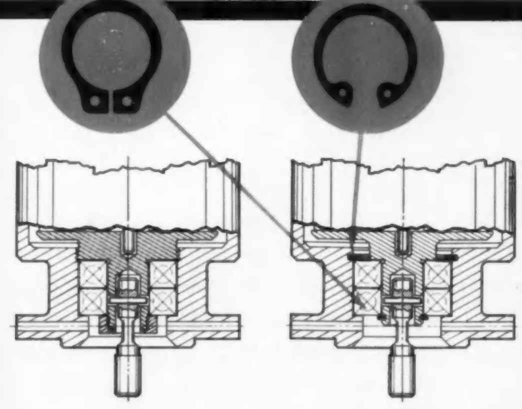
VEEDER-ROOT INCORPORATED
HARTFORD 2, CONNECTICUT

STOCKS OF STANDARD COUNTERS AVAILABLE AT
Greenville, S. C. • Chicago 6, Ill. • New York 19, N. Y. • Los Angeles • San Francisco
Montreal 2, Canada • Offices and Agents in Other Principal Cities

10 Waldes Truarc rings speed assembly—Eliminate parts and machining in precision control

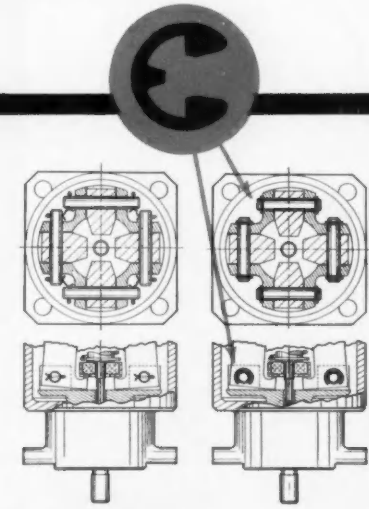
Kahn Rotary Speed Control

Kahn and Company, Inc., of Hartford, Conn., use a total of 10 Waldes Truarc Retaining Rings in this new mechanical-electric translator for automatic control of rotary speed. Truarc rings act as positioners and retainers to eliminate parts, simplify operations, save labor, and speed assembly.



Rotor Installation. In the old way, ball bearing was retained by a threaded shoulder and threaded bearing cup retainer.

New way, using two Truarc Rings (Series 5100 and 5000) eliminates 4 threading operations, bearing shoulder and threaded bearing cup. Assembly is quicker and easier, two ounces lighter.



Flyweight Assembly. Formerly, 2 holes had to be drilled in each of the 4 pivots, and 8 cotter pins were required.

The new way, using 8 Truarc E-Rings (Series 5133), replaces holes with grooves, reduces pivot size, leaves no projecting parts. Rings snap into place, speed assembly time by three minutes per unit.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product...to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring. **36 functionally different types**...as many as 97 different sizes within a type...5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U. S. A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today...let our Truarc engineers help you solve design, assembly and production problems...without obligation.

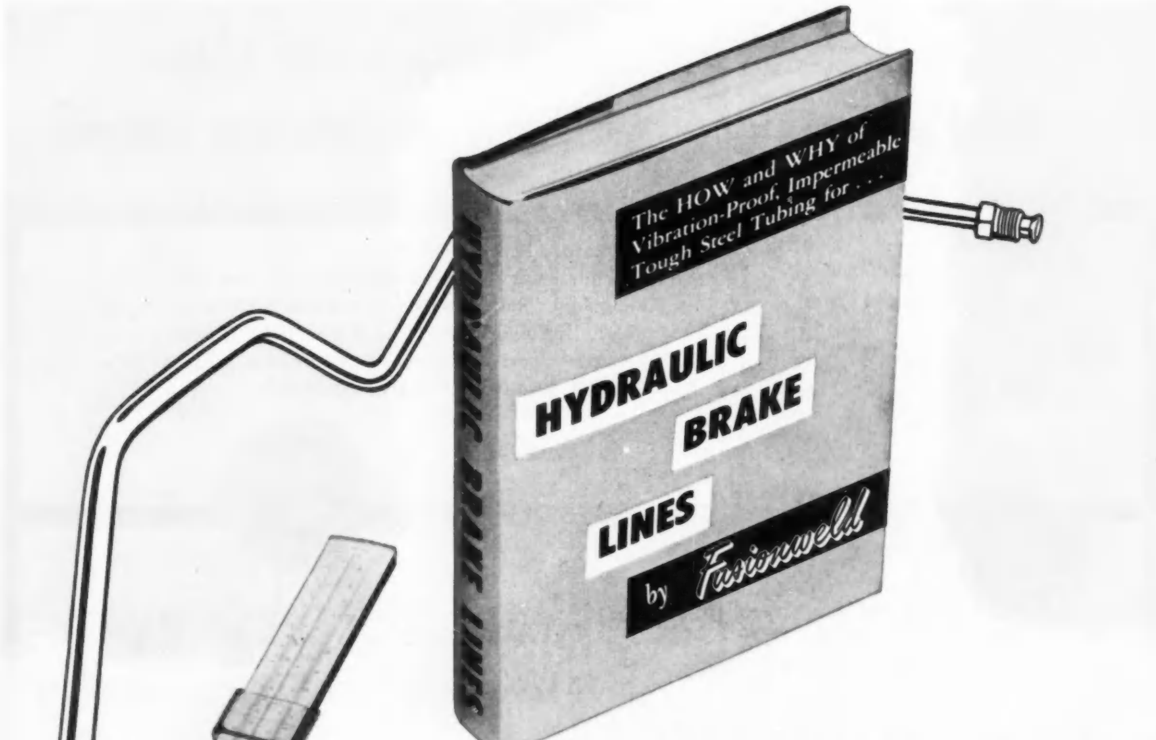
For precision internal grooving and undercutting ... Waldes Truarc Grooving Tool!

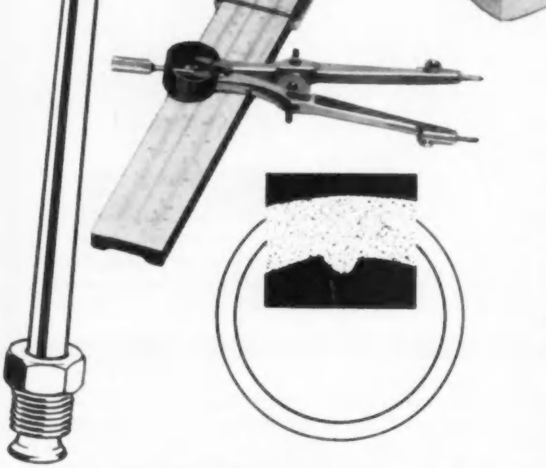
WALDES
TRUARC®
RETAINING RINGS

Send for new catalog supplement

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
(Please print)
Name..........
Title..........
Company..........
Business Address..........
City..........*Zone*..........*State*..........
SA018

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787. and other U. S. Patents pending. Equal patent protection established in foreign countries.





The microphotograph of a cross section of Fusionweld at the weld illustrates the complete homogeneity of grain structure present in both the weld and adjacent wall. This important feature insures a tougher, stronger, more ductile tubing, completely impermeable. The result is easier, more reliable forming and fabricating of a single wall tubing that is proof against splitting, tearing and checking—regardless of intricate flaring, beading, swaging or sharp angle bending specifications.

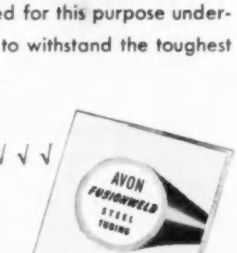
Fusionweld, because of its reputation for reliability, ease of forming, minimum scrap loss and volume production economies is rapidly becoming the preferred steel tubing for hydraulic automotive brake lines. All Fusionweld specified for this purpose undergoes a rugged impact test of 6000 PSI to withstand the toughest braking tests in car, bus, truck or tractor.

HERE'S PART OF THE STORY

Fusionweld thin-wall steel tubing is produced by a special technique developed in our mills by a hi-cycle type of resistance welding. The tubing is then annealed in specially designed furnaces and cold drawn by a unique die sinking process which provides a perfectly smooth O.D., imparts a high degree of tensile strength and toughness, making it especially resistant to vibration and fatigue—hence ideal for automotive applications.

√ √ √ *NOW GET THE PROOF* √ √ √

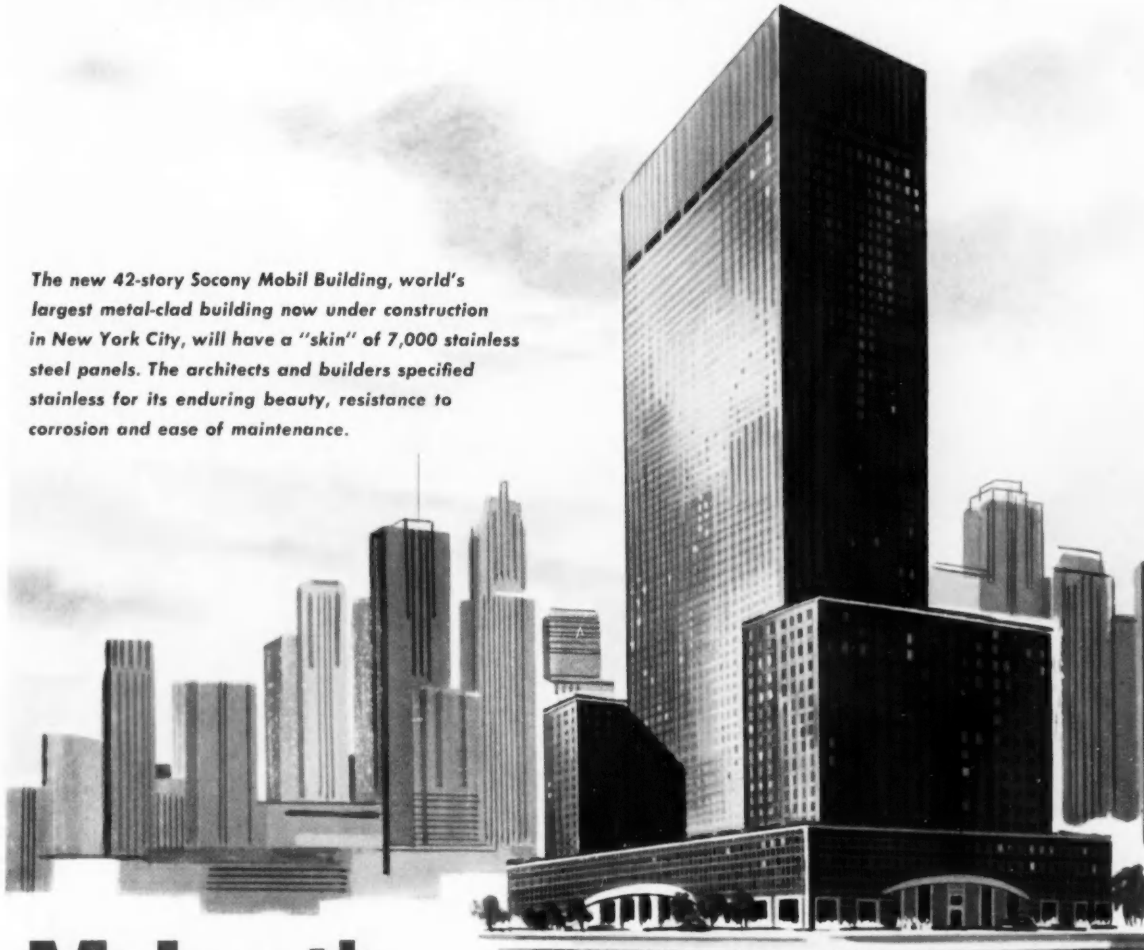
Let us tell you the complete story on Fusionweld for brake lines . . . its amazing performance records and cost cutting advantages. Today millions of feet monthly are employed by motor car manufacturers.



Our current catalog will be mailed on request.

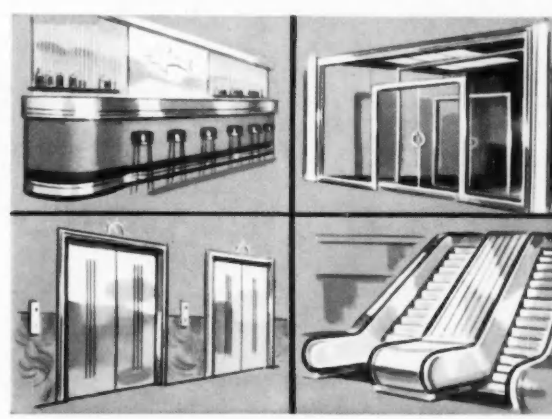
AVON TUBE DIVISION
HIGBIE MANUFACTURING CO.
ROCHESTER • MICHIGAN

modern design specifies stainless steel



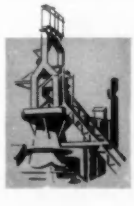
The new 42-story Socony Mobil Building, world's largest metal-clad building now under construction in New York City, will have a "skin" of 7,000 stainless steel panels. The architects and builders specified stainless for its enduring beauty, resistance to corrosion and ease of maintenance.

McLouth
STAINLESS
Steel
for buildings



In fixtures, trim, curtain walls and hundreds of other applications you will profit by using McLouth Stainless Steel.

For the product you make today and the product you plan for tomorrow specify McLouth high quality sheet and strip Stainless Steel.



McLOUTH STEEL CORPORATION
Detroit, Michigan

MANUFACTURERS OF STAINLESS AND CARBON STEELS

Douglas announces opportunities for **MISSILES ENGINEERS** at Santa Monica

This is your invitation to join the nation's most experienced team of missiles engineers with 14 years' background in successful design and construction of missiles for the armed forces.

Enlarging previous activities, a new and independent Missiles Engineering Department adjacent to Missiles Manufacturing has recently been set up at Douglas in view of the increasing importance of missiles in the nation's defense. This new department looks ahead to rapidly expanding growth in a challenging field.

For engineers who like "frontier" work in creative design, this new Douglas department will have unusual appeal — with no ceiling on advancement.

To look into the immediate and the long range advantages this opportunity offers you, contact E. C. Kaliher, Engineering Personnel Manager, Missiles; Douglas Aircraft Company, Santa Monica, California.

8 long-term projects

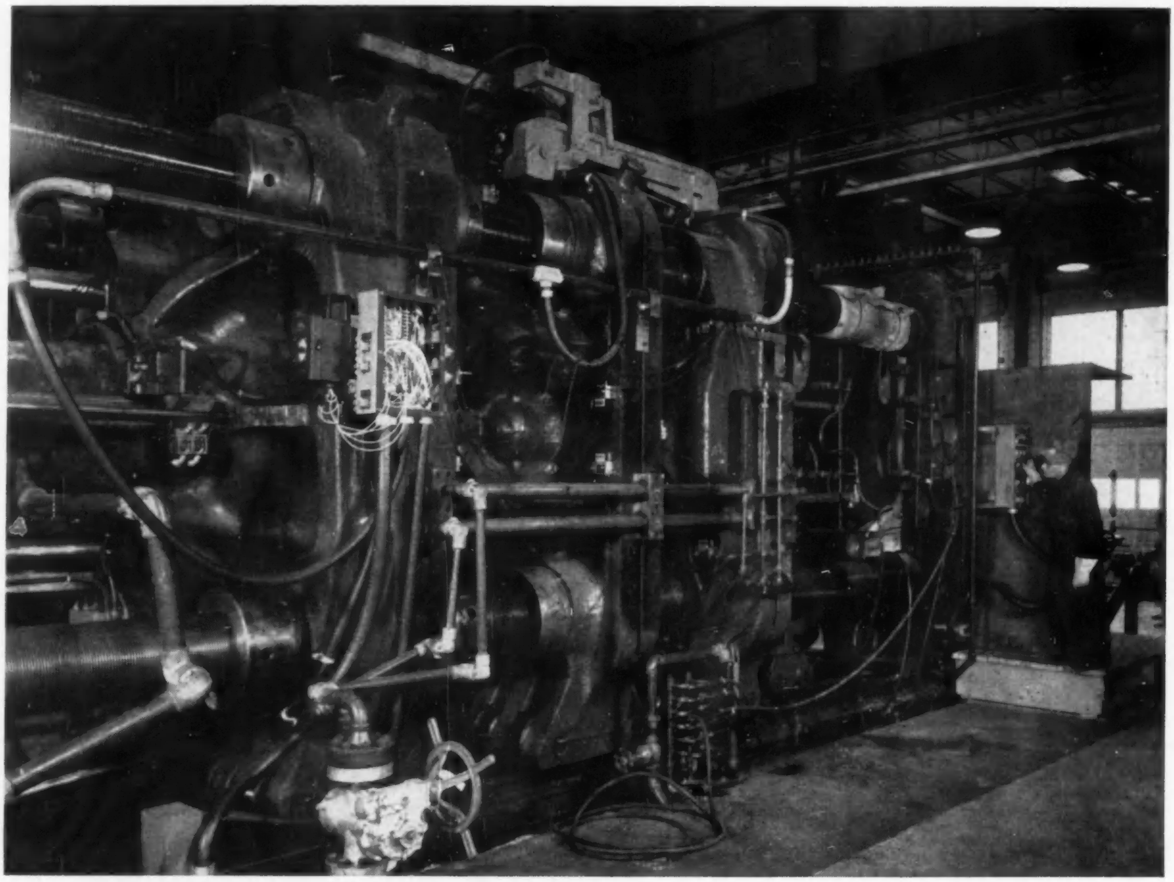
Now in progress at Douglas are 8 major missiles projects under contracts from the Air Force, Army and Navy. Among them are 3 missiles now in production — Honest John (above), Nike and Sparrow 1.

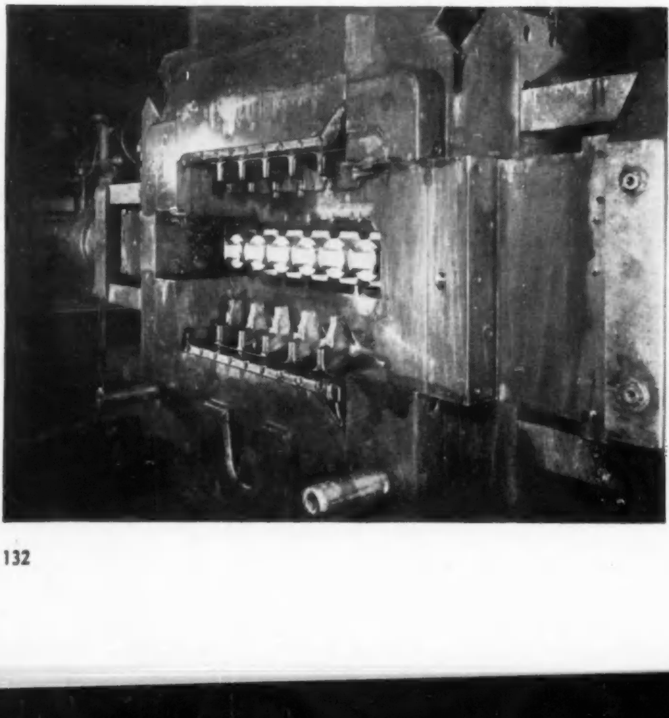
Missiles by *DOUGLAS* **First in Aviation**

An important milestone in the automotive world !

turn page for full story

The world's largest





At the Doehler-Jarvis plant in Toledo, six-cylinder in-line die-cast aluminum engine blocks have been successfully produced on the new 72" machine. The block is an important step forward in the final development of an aluminum automobile engine. The six-cylinder block offers better car performance because of its great weight saving over a similar gray iron block. The aluminum block also promises greater efficiency because of its better heat conductivity. Wet-sleeve design permits better cooling. Smooth die-cast internal surface eliminates restrictions usually found in gray iron blocks.

die-casting machine

OPENS A NEW ERA IN AUTOMOTIVE DESIGN!

ABOUT one year ago, the largest die-casting machine in the world was completed and put into operation by Doehler-Jarvis Division of National Lead Company in cooperation with Kaiser Aluminum & Chemical Corporation.

Recently, the huge machine successfully produced the largest aluminum die-casting ever made —a six-cylinder in-line engine block weighing about 130 pounds less than a similar gray iron block.

The successful production of such a large and complex die-casting points the way to the design of other large die-cast aluminum automotive parts.

Such parts would benefit from all the advantages of the die-casting process, which is inherently suited for mass production of a wide variety of cast parts requiring close dimensional tolerances, smooth surfaces, clean and sharp detail and thin metal sections.

Because of their inherent smoothness and accuracy, die-castings frequently eliminate need for machining on many flat surfaces, and holes for through-bolts and tap-drills can be cored to size.

It is also possible to combine mounting pads, instrument housings, numerals, lettering, emblems, trademarks and other details as integral parts of main castings, thereby eliminating the need for purchasing and assembling as separate items.

Automotive engineers and designers should investigate this new Doehler-Jarvis Division of National Lead development in aluminum die-casting without delay to see if your existing or new designs can take advantage of the new 72″ die-casting machine.

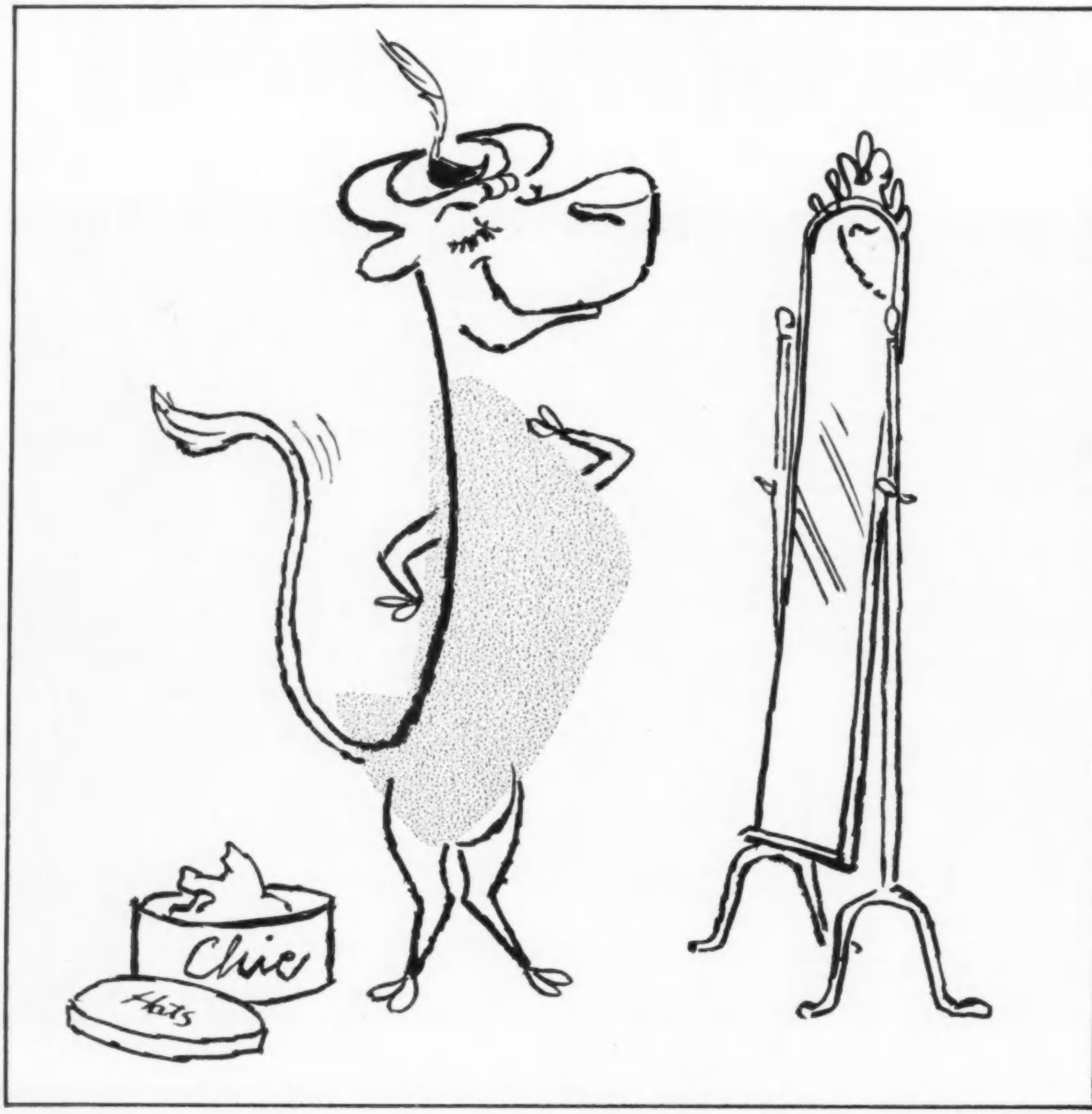
IF YOU NEED ASSISTANCE WITH ALUMINUM . . .

Let us work in partnership with you. We are eager to share our knowledge of aluminum and engineering skill. Development engineers will gladly provide engineering service and counsel on design and alloy selection which may give you a better product at a lower cost.

Kaiser Aluminum & Chemical Sales, Inc., *General Sales Office*, Palmolive Building, Chicago 11, Illinois; *Executive Office*, Kaiser Building, Oakland 12, California; DETROIT OFFICE, *1414 Fisher Building, Detroit 2, Michigan, Phone Trinity 3-8000.*

Kaiser Aluminum

setting the pace—in growth, quality and service



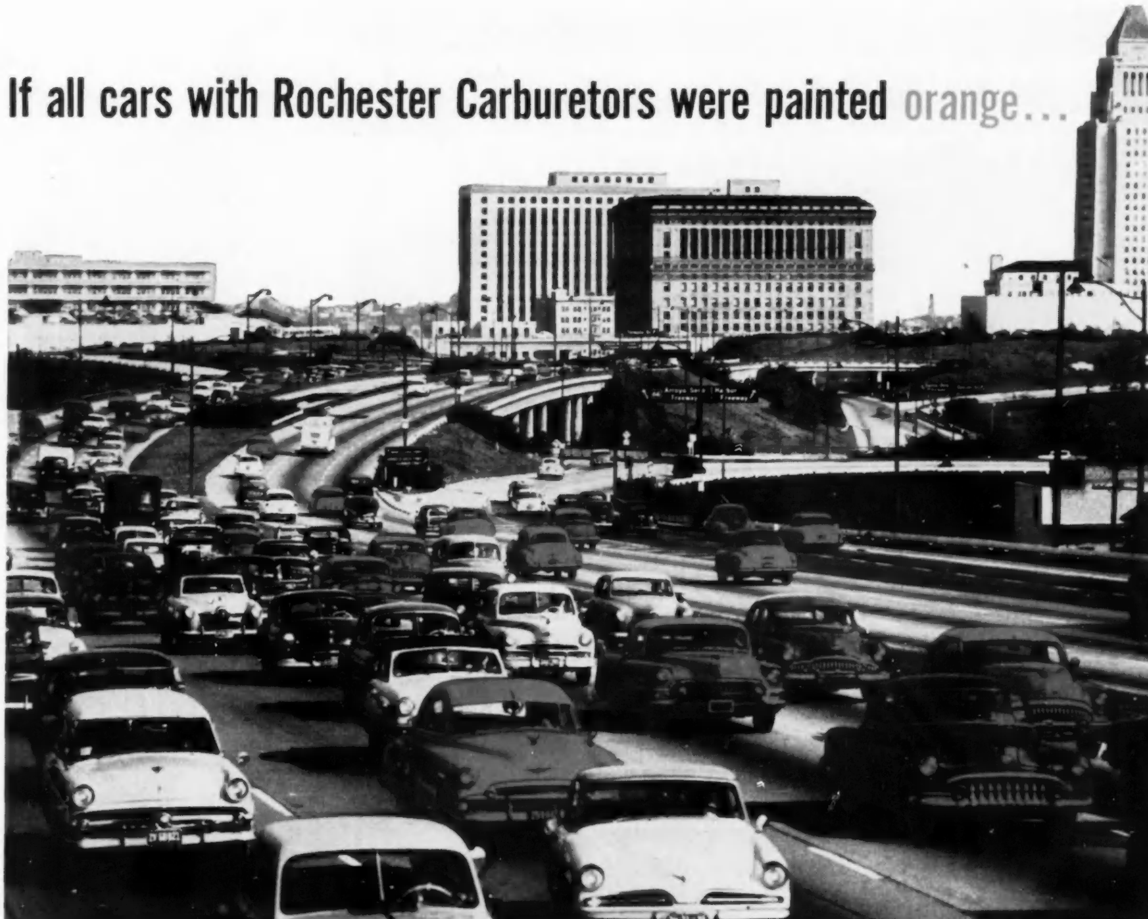
For high style... genuine Leather

The top of automotive fashion is genuine leather upholstery.
Both men and women, young and old, know that the smartest upholstery
for their cars is genuine leather. Its colors are more beautiful,
its texture more luxurious—and it feels so good!
It's easy to sell the advantages of genuine leather!

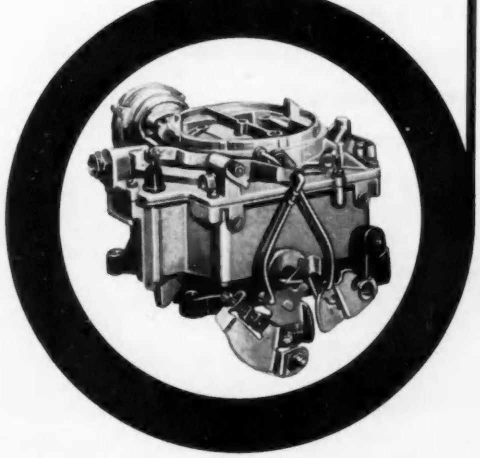
Only genuine leather wears as well as it looks

THE UPHOLSTERY LEATHER GROUP, INC. • **99 West Bethune, Detroit 2, Mich.** • 141 E. 44th St., New York 17, N. Y.

If all cars with Rochester Carburetors were painted orange...



the Los Angeles Freeway would look like this!



Rochester gives 'em the gas! Nearly half the new cars on the road today are "fed" by Rochester Carburetors. These modern high-compression engines are assured of the right mixture of gas and air to deliver top performance in every driving situation. Rochester Carburetors are rugged and responsive from pickup to passing speed . . . in freezing cold or blazing heat. They're dependable, durable and specifically designed to feed the world's finest engines. That's why you'll find Rochester Carburetors on the new Cadillac, Buick, Oldsmobile, Pontiac and Chevrolet!

CARBURETORS BY ROCHESTER PRODUCTS

ROCHESTER PRODUCTS DIVISION OF GENERAL MOTORS CORPORATION ROCHESTER N.Y.

advanced thinking at

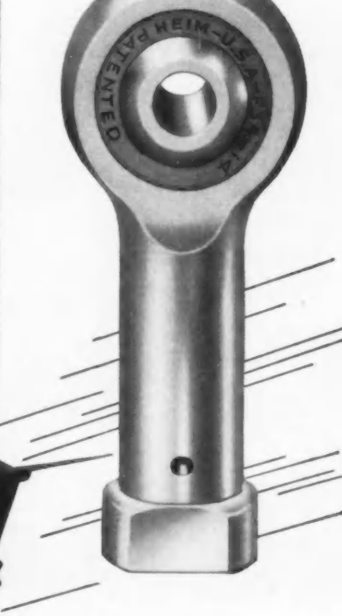
MARTIN...

uses the efficient

HEIM

Unibal

ROD ENDS



in the new *Sea Master* XP6M-1 multi-jet attack seaplane.
Built for the Navy at Martin's Middle River plant, the big, swept-wing flying boat is powered by four jet engines, and is designated in the over 600 mile-per-hour class. Four Allison J-71 jet engines are equipped with afterburners to give the craft additional speed and power.

The Heim Unibal consists of a single ball, revolving in bronze bearing inserts, in an outer member of carbon steel, approved aircraft steel, or any other suitable material. They are used extensively by the aircraft industry, and were chosen by Martin for use in the fabulous, new Sea Master for their strength, efficiency, and dependability.

Heim Unibal Rod Ends are manufactured in many sizes to cover a variety of applications, other than in the aircraft industry, and fill a long-felt need for a bearing that corrects misalignment conditions, and has maximum carrying capacity because of their greater surface supporting area. They will take a greater radial and axial thrust load.

Tell us your bearing problem, and our Engineering Department will be pleased to submit their recommendations for any application.

THE HEIM COMPANY
FAIRFIELD, CONNECTICUT

happy balance between dependable performance and moderate cost

Tru-Rol *precision, steel-cage, heavy-duty bearing with contoured guide lips assuring true right-line rolling, maintained roller alignment and thin oil film.*

● Rollway's *TRU-ROL* Steel-Cage Bearings afford wide latitude in balancing *dependable* performance, *long* life, and *high load* capacity against *moderate* cost. They rate high in any comparison on a cost-performance basis.

A choice of stamped steel retainers with contoured guide lips, or steel segmented retainers assure true rolling and an evenly distributed *thin* oil film — *big factors in reducing power losses and heating.*

"Crowned" Rollers Relieve End Stress

TRU-ROL offers the extra advantage of a finish-ground "crown" radius on the roller ends. That relieves high end-stress and insures uniform load distribution over the entire length of the roller. The result: *TRU-ROL* Steel Cage Bearings carry heavier loads over longer periods without excessive end-fatigue. They are less affected by slight misalignment or shaft deflection.

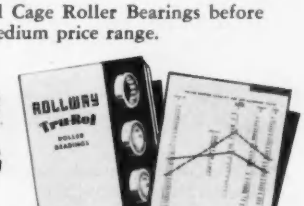
Investigate *TRU-ROL* Steel Cage Roller Bearings before selecting any bearing in the medium price range.

TYPE D

Rollway Metric Series Steel Cage Roller Bearings

● Rollway Metric Series Steel-Cage Bearings offer the greater load capacity of solid cylindrical rollers, plus the true right-line rolling of trunnion rollers turning in a rigid steel cage. There's no roller skew, no pinch out, no cam action. Design permits maximum bearing capacity . . . within small space . . . at moderate cost.

FREE CATALOG



ROLLWAY BEARINGS

COMPLETE LINE OF RADIAL AND THRUST CYLINDRICAL ROLLER BEARINGS

ROLLWAY BEARING CO., INC.
541 Seymour St., Syracuse 4, N.Y.

Please send a free copy of New Tru-Rol Catalog with extra Alignment Charts.

Name__________ Title__________

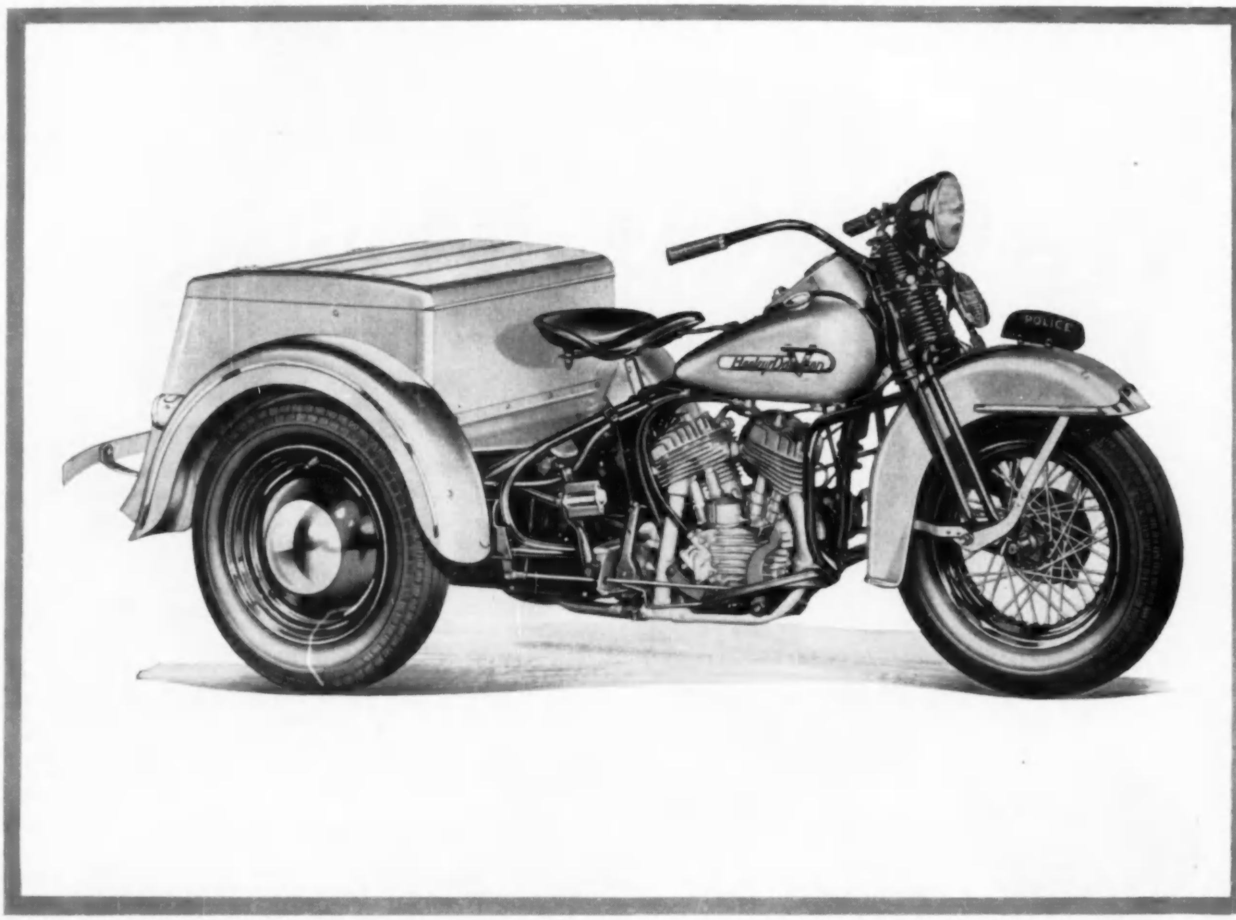
Firm Name__________

Street__________

City__________ Zone____ State__________

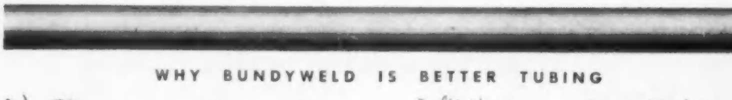
ENGINEERING OFFICES: Syracuse • Boston • Chicago • Detroit • Toronto • Pittsburgh • Cleveland • Milwaukee • Seattle • Houston • Philadelphia • Los Angeles • San Francisco

Sturdy police motorcycle

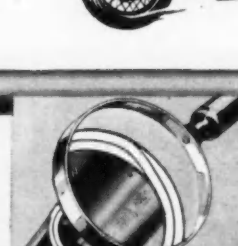


This rugged Harley-Davidson Servi-Car helps keep police forces across the nation functioning at top efficiency. Made by the Harley-Davidson Motor Company, Milwaukee, Wisconsin, the Servi-Car uses dependable Bundyweld Steel Tubing for fuel lines (shown above), and brake lines – 6 parts in all, totaling 9′ 2¾″.

WHY BUNDYWELD IS BETTER TUBING



Bundyweld starts as a single strip of copper-coated steel. Then it's . . . continuously rolled twice around laterally into a tube of uniform thickness, and passed through a furnace. Copper coating fuses with steel. Result . . . Bundyweld, double-walled and brazed through 360° of wall contact.



NOTE the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.

depends on Bundyweld for vital tubing lifelines

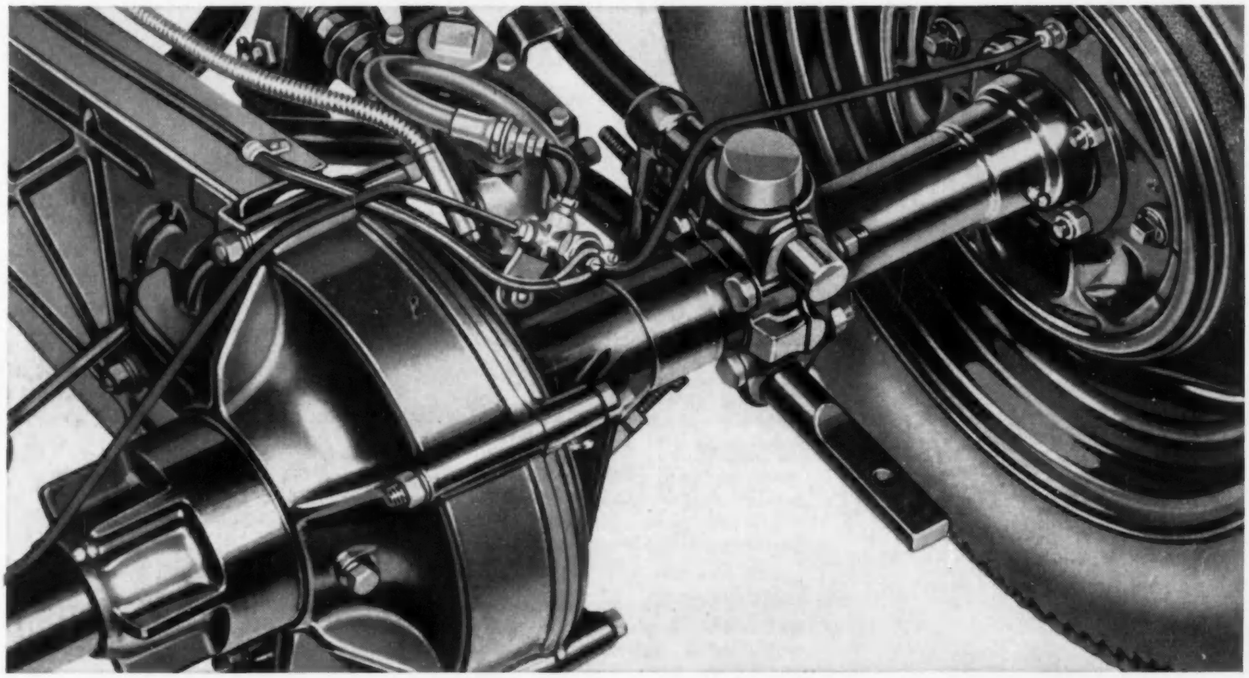
Whatever the emergency—fire, disaster, lawbreaking, traffic accident—the police officer patrolling his beat on a Harley-Davidson Servi-Car reaches the spot in a hurry.

Naturally, police officers must be able to count on their machines—*in any emergency*. That's why the manufacturer of these sturdy Servi-Cars specifies extra-reliable Bundyweld Steel Tubing for vital brake and fuel "lifelines."

Here's why you, too, can profit by switching to this outstanding tubing: Bundyweld is leakproof by test; thinner walled, yet stronger; is remarkably resistant to vibration fatigue; has high bursting strength. It's the only tubing double-walled from a single metal strip, copper-brazed throughout 360° of double-walled contact.

In addition, Bundy backs up the industry's finest small-diameter tubing with these unexcelled plus-services: expert technical assistance and engineering know-how; unbeatable fabrication facilities; custom-packaging of orders; and a sincere willingness to help you with your tubing problem. Call, write, or wire us.

BUNDY TUBING COMPANY • DETROIT 14, MICH.

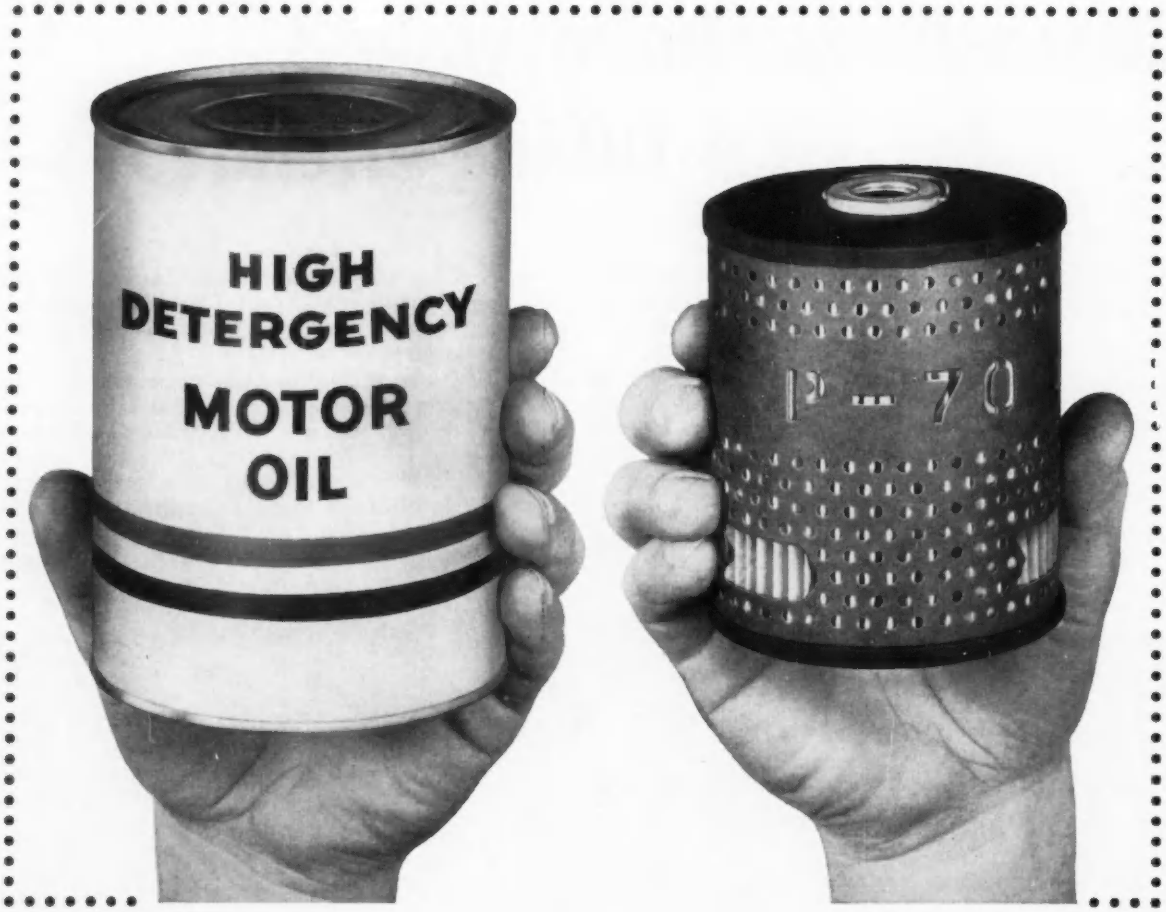


Heavy-duty auto-type hydraulic brakes offer the last word in motorcycle safety. Naturally, the brake lines are made of extra-strong Bundyweld. Shown above: rear-wheel brake lines.

BUNDYWELD TUBING®

DOUBLE-WALLED FROM A SINGLE STRIP

Bundy Tubing Distributors and Representatives: ***Cambridge 42, Mass.:*** Austin-Hastings Co., Inc., 226 Binney St. • ***Chattanooga 2, Tenn.:*** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • ***Chicago 32, Ill.:*** Lapham-Hickey Co., 3333 W. 47th Place • ***Elizabeth, New Jersey:*** A. B. Murray Co., Inc., Post Office Box 476 • ***Los Angeles 58, Calif.:*** Tubesales, 5400 Alcoa Ave. • ***Philadelphia 3, Penn.:*** Rutan & Co., 1717 Sansom St. • ***San Francisco 10, Calif.:*** Pacific Metals Co., Ltd., 3100 19th St. • ***Seattle 4, Wash.:*** Eagle Metals Co., 4755 First Ave., South ***Toronto 5, Ontario, Canada:*** Alloy Metal Sales, Ltd., 181 Fleet St., E. • **Bundyweld nickel and Monel tubing are sold by distributors of nickel and nickel alloys in principal cities.**



Purolator's "SELECTIVE" FILTRATION leaves additives in

Beneficial additives stay in as HD and heat-resistant lube oils pass through the Micronic* element of a Purolator filter . . . even though the element is straining out sludge, water and impurities as small as one micron (.000039-inch).

It's one of the reasons why original equipment manufacturers in the automotive field use more Purolators than any other make of filter. Besides this "selective" filtration, the accordion-pleated Micronic* element provides ten times the area of older types, making possible:

- ***High flow rates with minimum pressure drop.* Purolators themselves can be small . . . yet operate with pumps of standard size.**
- ***Maximum dirt storage capacity* . . . for long, efficient service life before replacement.**

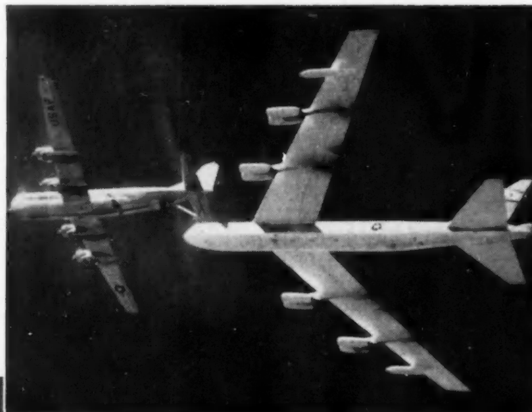
*Registered Trade Mark

Micronic elements do not channel. They are waterproof and warp-proof and remain unaffected by engine temperatures. There's a Purolator to fit every vehicle, tractor and other gasoline- or diesel-engine-powered unit in service today. Write for our automotive catalog, No. 2054, to Purolator Products, Inc., Rahway, N. J., Dept. A1-117

PUROLATOR

"FIRST IN THE FIELD OF FILTERING"

PUROLATOR PRODUCTS, INC., Rahway, New Jersey



MARMAN COUPLINGS Simplify Fuel Line Installation on KC-97 TANKERS

Production of KC-97 tankers for jet bomber refueling required interconnecting JP-4 fuel lines. Boeing engineers chose lightweight tubing coupled with dependable Marman stainless steel couplings for these lines. Installation was made easy and air frame modification was held to a minimum.

Marman's wide range of couplings, clamps and straps provide a ready solution for all types of aircraft fastening and joining problems, as indicated by the additional applications pictured above. Write today for full information.

Support Junior Achievement
Junior Achievement Week, January 29–February 4

MARMAN PRODUCTS COMPANY, INC.

A SUBSIDIARY OF Aeroquip CORPORATION

11214 EXPOSITION BLVD., LOS ANGELES, CALIFORNIA

MARMAN PRODUCTS ARE MANUFACTURED UNDER VARIOUS U.S. AND FOREIGN PATENTS AND OTHER PATENTS PENDING

XIII

This is the thirteenth of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many in this field, including men of broad experience who may find it useful to review fundamentals from time to time.

Manganese in Alloy Steels

A common and economical alloying agent, manganese is both highly respected and highly essential. It is one of the most basic elements in alloy and carbon steels; in fact, all analyses contain manganese to some extent. Whenever the content exceeds 1.65 pct, manganese steels are classed as alloy steels.

Manganese is one of the energetic deoxidizers, and has less tendency to segregate within the ingot than most other common elements. It is quite beneficial to surface quality in all carbon ranges and minimizes "red shortness" or susceptibility to tearing and cracking at rolling temperatures.

Manganese contributes markedly to strength and hardness, but to a lesser degree than carbon. Actually, the effectiveness of manganese in this respect depends largely upon the carbon content, for higher-carbon steels are more affected by manganese than are the lower-carbon steels.

Another function of manganese is to decrease the minimum—or critical—cooling rate. In this connection it enhances the hardenability. As might be expected, high manganese content with increasing carbon has a tendency to lower ductility and weldability.

Fine-grained manganese steels attain unusual toughness and strength. Such steels are often used in the making of gears, spline shafts, automobile axles, steam valves, rifle barrels, cylinders for compressed gas, and many other products. With a moderate amount of vanadium added, manganese alloy steels are also used for forgings too large to be liquid-quenched properly.

As mentioned earlier, manganese is one of the most fundamental constituents of steel. If you would care to know more about its properties, applications, and effects in alloy combinations, Bethlehem technicians will be glad to work closely with you. The same holds true, of course, when your problem involves other elements of alloy steel.

And when you require new supplies of steel, remember that Bethlehem manufactures the entire range of AISI standard alloy grades, as well as special-analysis steels and all carbon grades. You can place complete confidence in their quality.

If you would like to have a reprint of this advertisement, or of the entire series from I through XIII, please write to us, addressing your request to Publications Dept., Bethlehem Steel Company, Bethlehem, Pa.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

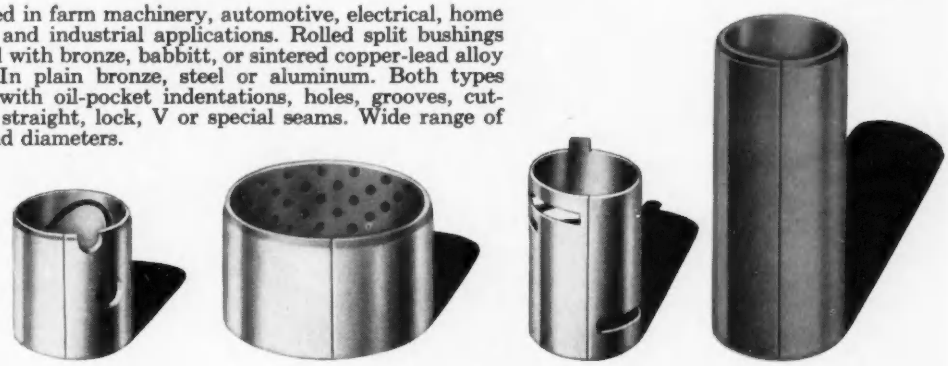
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

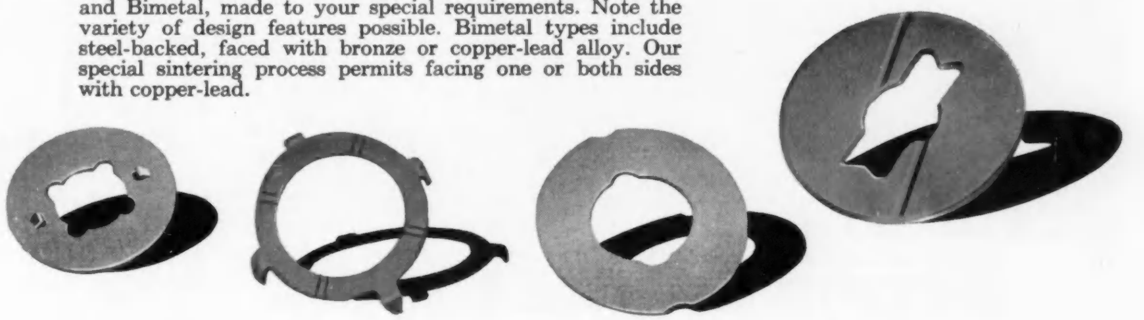
BUSHINGS

widely used in farm machinery, automotive, electrical, home appliance and industrial applications. Rolled split bushings in Bimetal with bronze, babbitt, or sintered copper-lead alloy on steel. In plain bronze, steel or aluminum. Both types available with oil-pocket indentations, holes, grooves, cut-outs, and straight, lock, V or special seams. Wide range of lengths and diameters.



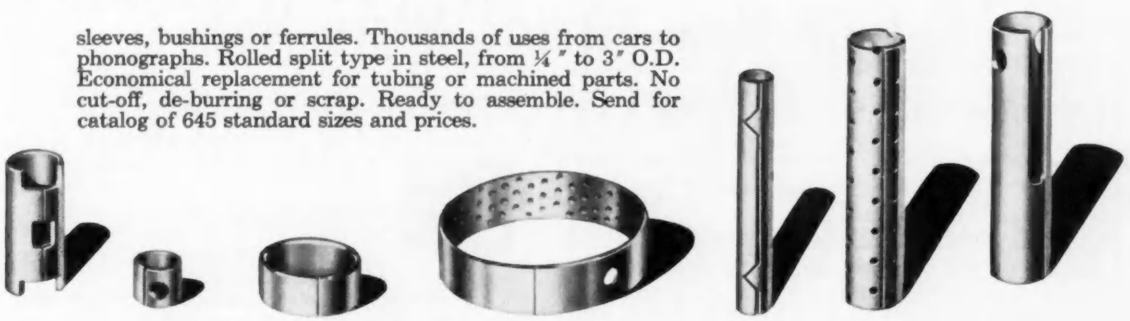
WASHERS

for automatic transmissions and similar applications. In bronze and Bimetal, made to your special requirements. Note the variety of design features possible. Bimetal types include steel-backed, faced with bronze or copper-lead alloy. Our special sintering process permits facing one or both sides with copper-lead.



SPACER TUBES

sleeves, bushings or ferrules. Thousands of uses from cars to phonographs. Rolled split type in steel, from ¼″ to 3″ O.D. Economical replacement for tubing or machined parts. No cut-off, de-burring or scrap. Ready to assemble. Send for catalog of 645 standard sizes and prices.



Here are exceptional facilities and equipment for low-cost quantity production of your requirements. Complete engineering service.

RESEARCH • DESIGN • METALLURGY • PRECISION MANUFACTURING

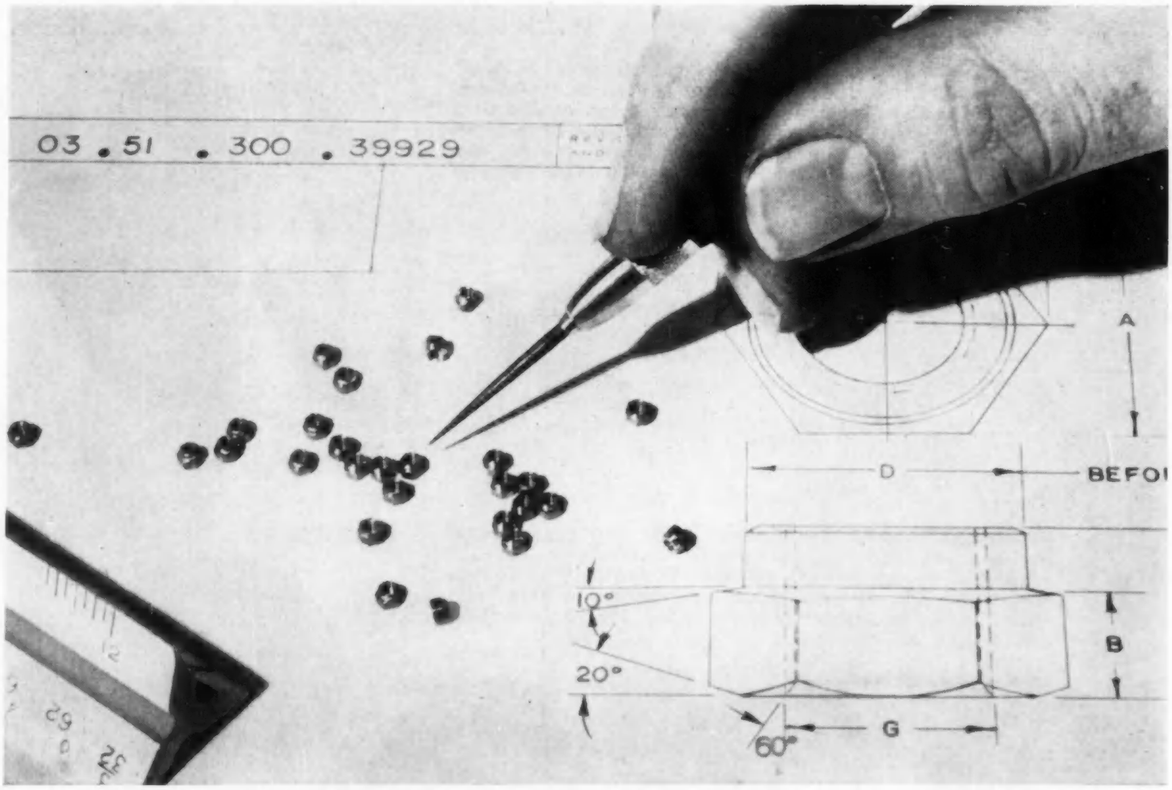
FEDERAL-MOGUL

DIVISION

FEDERAL MOGUL

SINCE 1899

FEDERAL-MOGUL-BOWER BEARINGS, INC., 11035 SHOEMAKER, DETROIT 13, MICH.



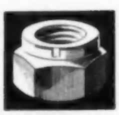
FLEXLOC Micro locknuts meet designers' needs for tiny precision nuts that retain strength and holding power in the smallest assemblies—servomechanisms, electronic and electrical equipment, all miniature devices.

Design Lighter, More Compact Products with New FLEXLOC Micro Nuts

Standard Miniature Locknuts Permit Design Engineers to Develop and Fasten Smaller Assemblies Safely

SIZE	Across Flats		Shoulder Height		Across Corners	Height +.000 −.003
	MAX.	MIN.	MAX.	MIN.	MIN.	
0-80 NF-3B	.111	.107	.047	.042	.123	.075
1-64 NC-3B	.127	.123	.0635	.0585	.141	.090
1-72 NF-3B	.127	.123	.0635	.0585	.141	.090
2-56 NC-3B	.158	.153	.068	.063	.176	.105
2-64 NF-3B	.158	.153	.068	.063	.176	.105
3-48 NC-3B	.190	.183	.071	.066	.210	.120
3-56 NF-3B	.190	.183	.071	.066	.210	.120
4-40 NC-3B	.190	.183	.072	.067	.210	.120
4-48 NF-3B	.190	.183	.072	.067	.210	.120

STANDARD FLEXLOC Micros—in sizes ranging from 0-80 to 4-48—are available in brass (either plain or cadmium plated). Consult SPS for miniature nuts of other conventional materials.



New FLEXLOC Micro locknuts are smaller and lighter than regular FLEXLOCS of the same nominal diameter. Wrenches of smaller size are used to install them. Mating joints or flanges can be designed smaller—with no loss in strength or convenience of assembly.

FLEXLOC Micros have all the advantages of larger FLEXLOCS. One-piece, all-metal construction—nothing to put together, come apart, lose or forget. Use them as lock or stop nuts—they stay put anywhere on a threaded member as soon as the locking threads are fully engaged. Uniform locking torques insure accurate preloading. There are no nonmetallic inserts to pop out or deteriorate. Moisture, dryness, oil, temperatures to 250°F won't affect these Micro nuts. Just screw them on. They lock and stay locked. Vibration won't shake them loose.

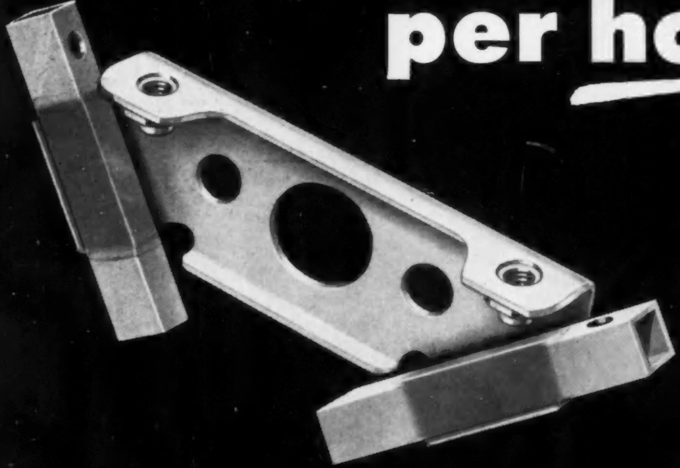
For complete information on FLEXLOC Micro locknuts, consult your authorized SPS distributor. Or write STANDARD PRESSED STEEL Co., Jenkintown55,Pa

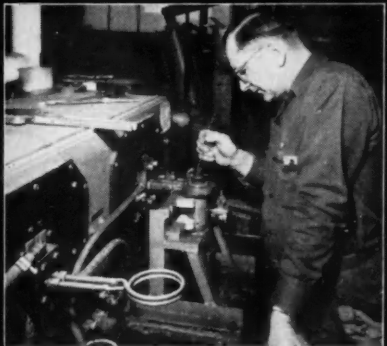
STANDARD PRESSED STEEL CO.

FLEXLOC® LOCKNUT DIVISION SPS

JENKINTOWN PENNSYLVANIA

JACK & HEINTZ Saves $15.84 per hour...





Jack & Heintz Inc. silver brazes over 25 different parts on this 15 KW, 10,000 cycle TOCCO machine.

with TOCCO* Induction Brazing

Brazing Costs Down

When Jack & Heintz engineers switched from torch brazing to automatic induction, brazing cost of these inverter brush mounts fell from $.05 to $.006 each—a reduction of 83% in direct labor costs alone! Additional savings result because less cleaning is required after TOCCO, and fuel costs are much lower, too.

Brazing Production Up

While costs dropped, production on the part zoomed—from 40 to 360 brazed assemblies per hour. Furthermore, rejects and scrap, formerly high, are now negligible.

Versatility

The part shown is just one of over 25 parts, large and small, which alert J & H engineers have converted from old-fashioned brazing methods to modern, automatic TOCCO. Overall brazing costs (TOCCO brazing versus former methods used) are down 75%—brazing speed, up 100%.

* * *

If the manufacture of *your* product involves brazing, heat-treating, forging or melting of ferrous or non-ferrous metals, don't overlook TOCCO as a sound method of increasing production, improving product quality and slashing costs.

THE OHIO CRANKSHAFT COMPANY

TOCCO

*Trade Mark Reg. U. S. Pat. Off.

Mail Coupon Today

NEW FREE BULLETIN

THE OHIO CRANKSHAFT CO.
Dept. Q-1, Cleveland 5, Ohio

Please send copy of "Typical Results of TOCCO Induction Brazing and Soldering".

Name________

Position________

Company________

Address________

City________ Zone____ State____

We're unveiling something terrific in Parlor 3. Don't miss it.
S. A. E. Annual Meeting, Sheraton-Cadillac Hotel, Detroit. See "Salute to the S. A. E.,"
the Alcoa Hour Commercial, Sunday Evening, January 8, NBC-TV

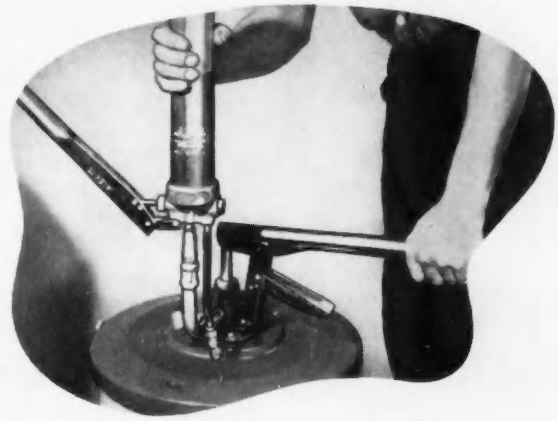
WE CHOSE ALCOA ALUMINUM MILL PRODUCTS

Your Guide to the Best in Aluminum Value

YOUR PRODUCTION GOES UP...

when you switch lubrication methods from

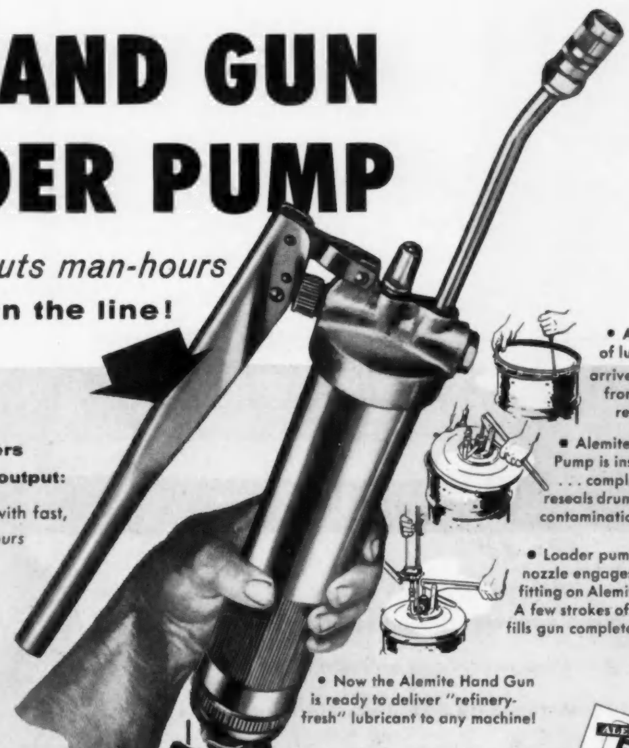
Backward to Forward!



ALEMITE HAND GUN WITH LOADER PUMP

reduces downtime... cuts man-hours

...saves right down the line!



Why more and more plant managers look to Alemite lubrication for greater output:

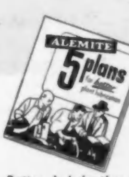
Time studies prove it! Refilling hand grease guns with fast, efficient Alemite Loader Pumps saves you *15 man-hours* for every 400-pound drum of lubricant, compared with loading the old-fashioned hand-and-paddle way!

You eliminate the cost, mess and fire hazard of "oil-room" spillage. With Alemite equipment you can *transfer, load and apply* lubricant that you know is *completely* free of dirt, grit or abrasives. Machine-hours are saved, too! With better lubricated bearings, machines stay new longer!

Alemite can furnish a hand gun of correct capacity for your operation—from 8 ounces to 2 pounds. And you get the pressure you need—up to 15,000 pounds! There is an Alemite Loader Pump to fit any standard lubricant container you normally use—stationary models for 100-lb. and 400-lb. drums; portable models for 25-lb. and 35-lb. pails.

Ask your nearest Alemite supplier for full details.

- A drum of lubricant arrives—fresh from the refinery.
- Alemite Loader Pump is inserted . . . completely reseals drum against contamination.
- Loader pump nozzle engages fitting on Alemite gun. A few strokes of pump fills gun completely.
- Now the Alemite Hand Gun is ready to deliver "refinery-fresh" lubricant to any machine!



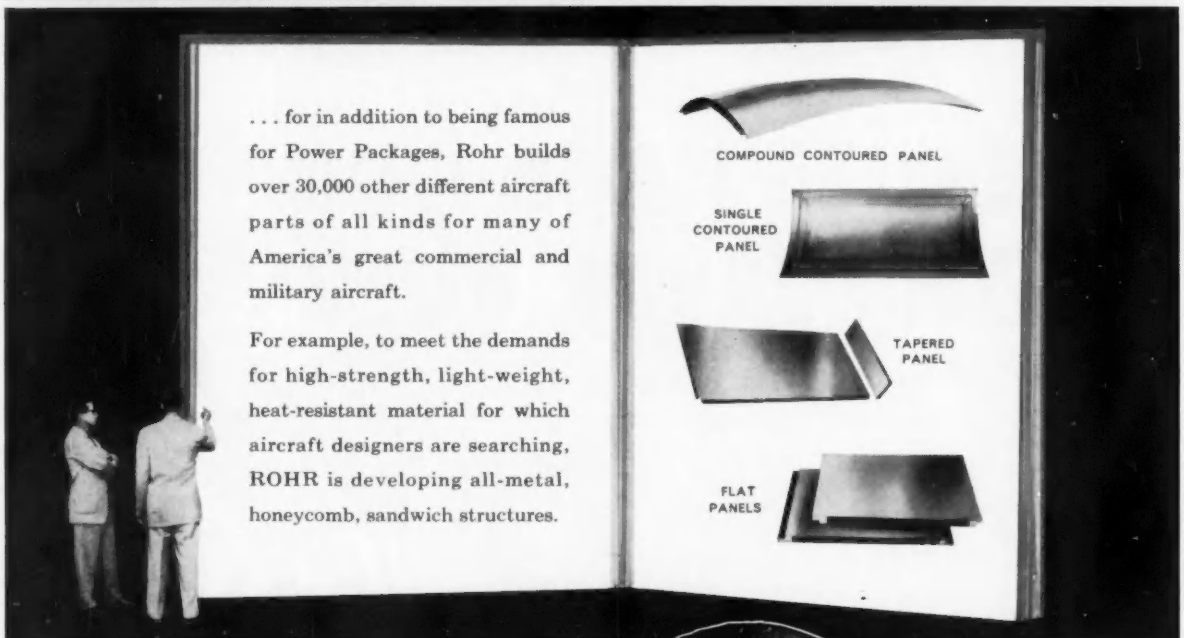
ALEMITE
REG. U. S. PAT. OFF.
Ask anyone in industry

A PRODUCT OF SW STEWART WARNER

***FREE!* New Booklet:**
"5 Plans for Better Lubrication"
Alemite, Dept. JJ-16, 1850 Diversey Pkwy.
Chicago 14, Illinois

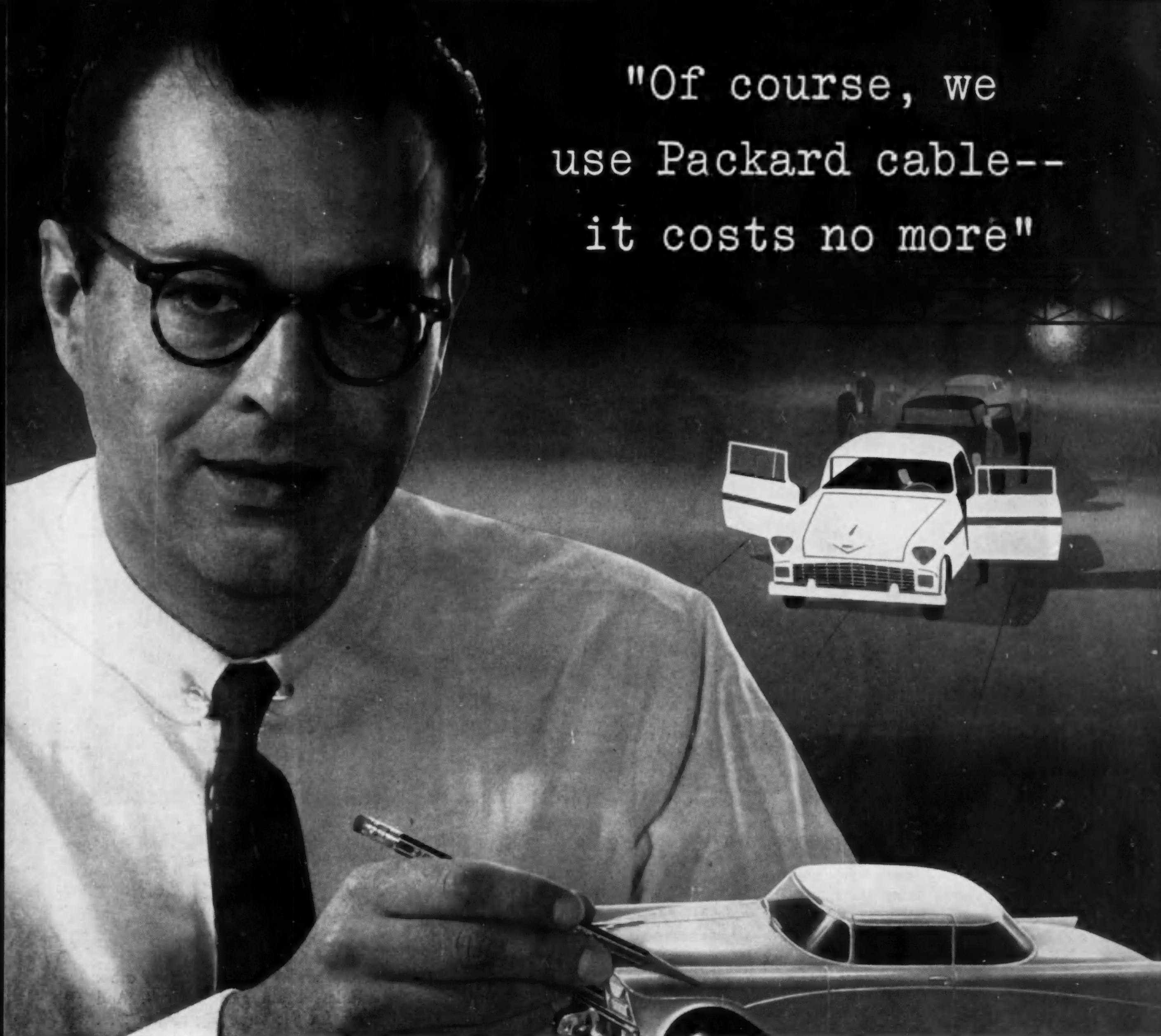
Please send me my FREE copy of "5 Plans for Better Lubrication."

Name ....
Company ....
Address ....
City .... State ....



When you want aircraft parts better, faster, cheaper . . . call on Rohr and the Rohr engineering skill and production know-how gained from building thousands of power packages and millions of other aircraft parts.

CHULA VISTA AND RIVERSIDE CALIFORNIA



Built to last—and priced right—Packard cable leads all others combined in preference and in sales

WHY TAKE CHANCES on cable troubles when it costs no more to specify the *best* in automotive cable and cable assemblies from Packard Electric. Here at Packard we have specialized for years in the development of tough insulation for all types of automotive cable—insulation so tough that it resists abrasion and chafing and cuts down the likelihood of electrical failure.

SPILLED FUEL, OIL OR HYDRAULIC FLUID, TEMPERATURE EXTREMES, EXPOSED INSTALLATIONS . . . whatever the problem, Packard has a cable to meet the conditions while delivering consistent, satisfactory performance. These are some of the important reasons why Packard cable is original equipment on more cars and trucks than all other brands combined!

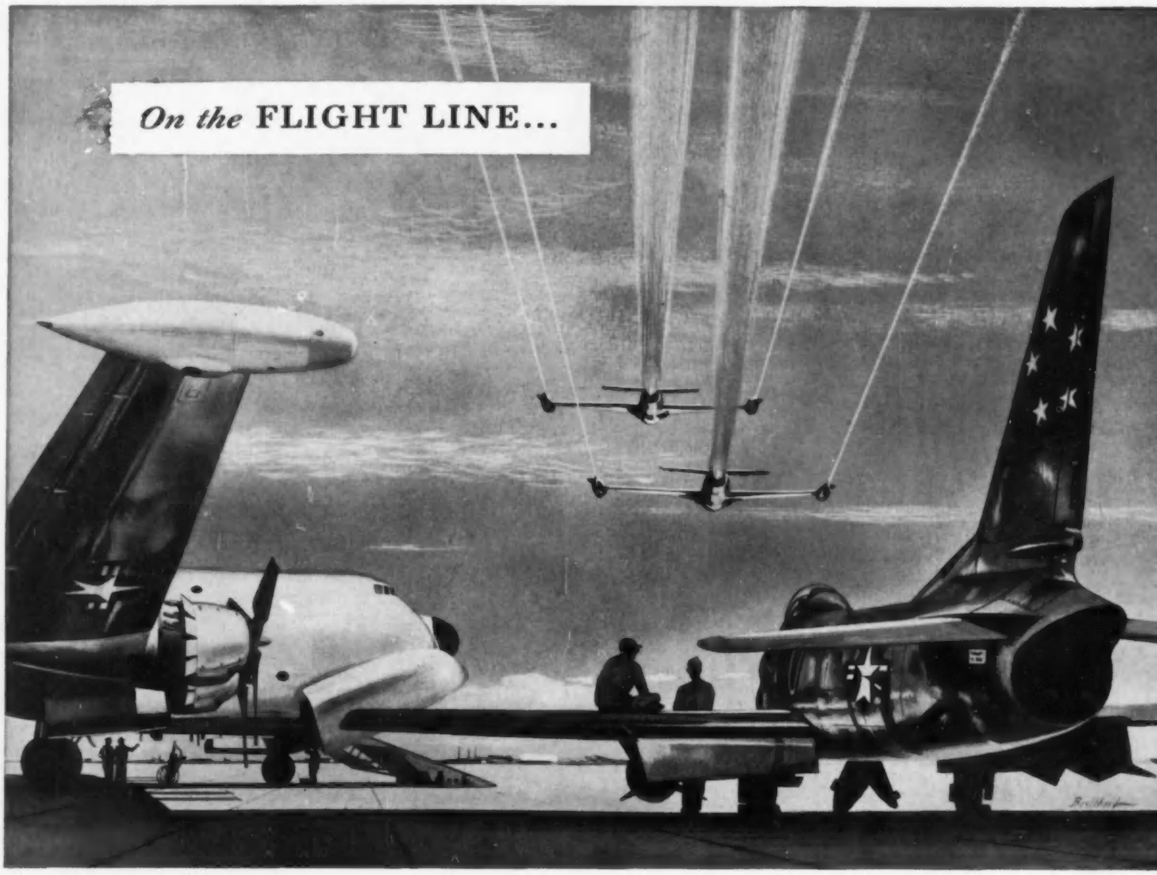
OUR ENGINEERS ARE AT YOUR SERVICE—ready to help design new components, if necessary, to solve a particular cable problem. It's another service to Packard customers. Why not take advantage of it today?

GM GENERAL MOTORS

Packard
REG. U.S. PAT. OFF.

Offices in Detroit, Chicago, and Oakland, California

Packard Electric Division
General Motors, Warren, Ohio

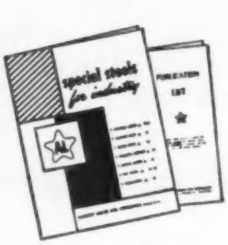


FIRST COST *can be the* LEAST COST *if it's the* LAST COST

★ ★ ★ ★ The Allegheny stainless and super high-temperature steels used in jet and rocket aircraft engines and equipment are pure economy, because they do the job that's required of them, and they *last!* They stand up under metal-killing conditions of heat, load and corrosion, and they're dependable.

There are lots of other jobs for stainless steel that aren't as spectacular, or perhaps as tough, as those aboard a jet. Like, for example, in hospital or kitchen equipment—or in cars, trains, appliances, buildings, etc. But, in these and thousands of other cases, stainless again gets the call. And usually, it's for the same big reason . . . because it not only does the job better, but lasts longer and costs less in the long run than any other material on the market.

And that brings up this question: where can Allegheny Stainless help *you* either to make money, or to save it? If you have a product or equipment problem, call us in . . . let our Engineering and Research Staff lend a hand. ***Allegheny Ludlum Steel Corporation, Oliver Bldg., Pittsburgh 22, Pa.***



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For These Publications

1. SPECIAL STEELS FOR INDUSTRY . . . 16 pages of essential data on the proper selection and application of principal AL special alloy products: stainless, tool and electrical steels and sintered carbides.

2. PUBLICATION LIST . . . a complete listing of all AL publications, both technical and nontechnical (over 100 in all), with a handy order form for your convenience.

ADDRESS DEPT. SA-73

Make it BETTER—and LONGER LASTING—with

AL Stainless Steel

AL ALLEGHENY LUDLUM ®

Warehouse stocks carried by all Ryerson Steel plants

ANOTHER EXAMPLE OF

VICKERS® Hydraulics

LeBlond Automated Crank Turning Equipment completely turns and faces over 55 V8 crankshafts per hour. One operator can handle two such machines.

in AUTOMATION

This new LeBlond Automated Crank Turning Equipment machines crankshafts at an exceptionally high rate. All operations of the Models LBA and PBA machines shown above are hydraulic with the exception of the actual rotation of the crank . . . here a Vickers hydraulic motor is used for braking and jogging the electric motor drive. All hydraulic power is supplied by Vickers Pumps and controlled by Vickers Valves.

In addition to the advantages inherent in hydraulic control, Vickers Hydraulics gives you the benefits of a nation-wide and full-time field engineering and service organization to assure correct application and operation with least maintenance. Vickers has the complete line of hydraulic equipment necessary to take undivided system responsibility . . . to eliminate any risk of incompatibility of hydraulic components.

The Vickers Application Engineer near you will be glad to demonstrate the many benefits you can obtain by using Vickers Hydraulics. Write for a copy of Catalog 5001A.

VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
1440 OAKMAN BLVD. • DETROIT 32, MICHIGAN
Application Engineering Offices:
ATLANTA • CHICAGO • CINCINNATI • CLEVELAND • DETROIT
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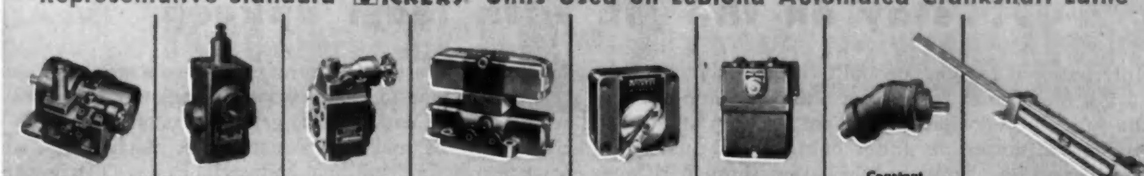
NEW YORK AREA (Summit, N.J.) • PHILADELPHIA AREA (Media)
PITTSBURGH AREA (Mt. Lebanon) • PORTLAND, ORE.
ROCHESTER • ROCKFORD • SAN FRANCISCO AREA (Berkeley)
SEATTLE • ST. LOUIS • TULSA • WASHINGTON • WORCESTER
IN CANADA: Vickers-Sperry of Canada, Ltd., Toronto

7301

Representative Standard VICKERS Units Used on LeBlond Automated Crankshaft Lathe



Two-Pressure Balanced Vane Pump | "Hydrocushion" Type Sequence Valve | Pressure Reducing Valve | Solenoid Controlled Pilot Operated 4-Way Valve | Flow Control Valve | Traverse and Feed Cycle Control Panel | Constant Displacement Piston Type Hydraulic Motor | "Compact" Hydraulic Cylinder

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

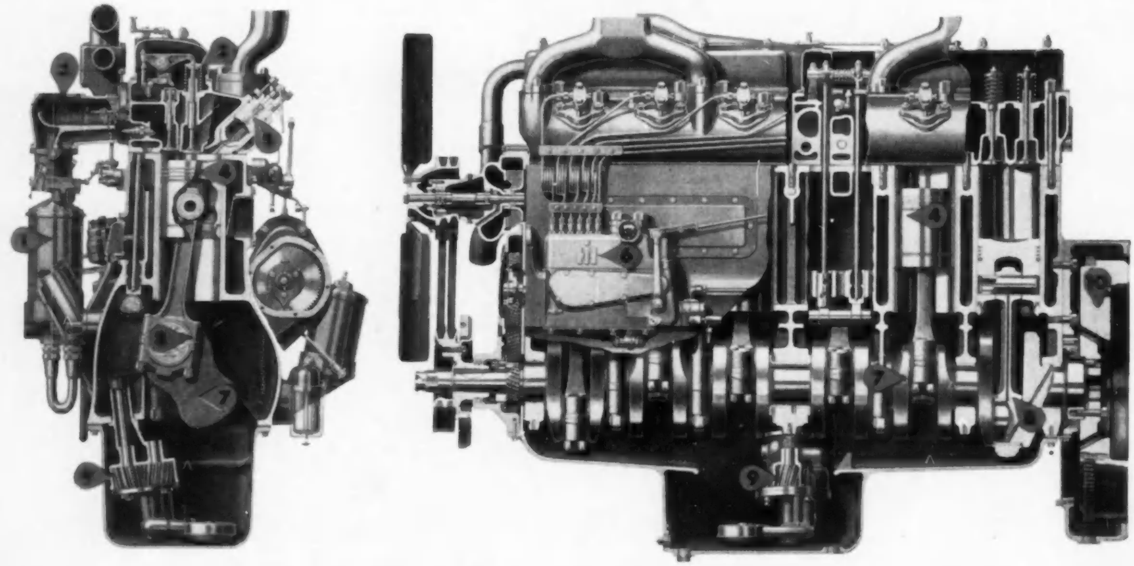
1 FULL FLOW OIL FILTER—Before oil goes under pressure to engine bearings, all harmful particles are removed by replaceable plastic-impregnated, full-flow filters.

2 POSITIVE ROTATORS EXTEND VALVE LIFE. Exhaust valve rotators keep valves turning, at all engine speeds, distributing heat uniformly around the valves to keep deposits from building up on stems and seats, and also to prevent sticking, scuffing, and burning.

3 POSITIVE ALL-WEATHER STARTING. Seconds-fast, International Diesels start in coldest weather on exclusive gasoline starting system. Cylinders are pre-heat conditioned to give complete, clean combustion, instantly, on switching to operation on Diesel fuel.

4 ALUMINUM-ALLOY PISTONS have a thick crown at the top for rapid dissipation of excess heat direct to the cooling water. Hardened, replaceable, cylinder sleeves, three compression rings, with top ring chrome-plated, plus two oil control rings assure long-lasting, gas-tight seal for high compression ratios of over 15 to 1 . . . providing top fuel and oil economy.

5 SIMPLE, SINGLE-HOLE, INJECTION NOZZLE and pre-combustion chamber set at 45° angle for smooth, clean combustion of low grade No. 2 fuel oil under all engine speed and load conditions.



6 NEW IH INJECTION PUMP: Single plunger type on four-cylinder models, twin-plungers on six-cylinders . . . provide all cylinders equal amounts of fuel, precisely metered to load, whether for idling, maximum horsepower, or maximum torque under overload. New, harder injection plungers have up to four times longer life.

7 HEAVY-DUTY FORGED CRANKSHAFT with large diameter, induction-hardened journals provides long-lasting, wear-resistant bearing surfaces . . . rifle-drilled for full pressure lubrication . . . dynamically balanced for smooth operation.

8 REPLACEABLE TRI-METAL BEARINGS provide precision clearance for full-pressure lubrication and thousands of hours of heavy-duty work. Smooth electroplating of white alloy metal over copper-lead, precision bonded to a steel back, carries heavy loads with minimum friction.

9 FULL-PRESSURE LUBRICATION for long life. Big, gear-type pump delivers oil under controlled pressure through full-flow filters and rifle-drilled passages to main and connecting rod bearings, piston pins, camshaft, timing gears, and valve rocker arms.

10 HEAVY FLYWHEEL helps to maintain uniform speed under widely varying load conditions. Available to match standard makes of clutches, fluid couplings, and torque converters.

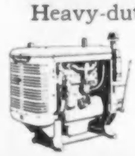
Hour after hour. . year after year

INTERNATIONAL ENGINES

. . . stay on the job with least upkeep

All International engines are built throughout to give you a full measure of power that stands up and stays on the job. They are precision-manufactured of thoroughly tested materials under continuous, quality-control inspection. Pressure lubrication through rifle-drilled crankshafts and internal passages assures trouble free performance. Inbuilt precision is fully protected from dirt and grit under the worst of job operating conditions by the best of fuel, oil, and air filters.

Heavy-duty radiators, power take-offs, and other factory-engineered power unit components are available to fit these long-life, money-saving engines to your job requirements. You can also get them as original equipment in most makes of construction machines. Call your nearest International Industrial Power Distributor or Power Unit Dealer for all the facts.



There's a size and type of International engine to fit your needs . . . from 16½ to over 200 hp.

INTERNATIONAL HARVESTER

INTERNATIONAL
INDUSTRIAL POWER

MAKES EVERY LOAD A PAYLOAD

Special reading about castings with special properties!

Now . . . the latest casting information! Campbell, Wyant and Cannon's new booklet, "One Source," is filled with interesting data on many types of castings. The section on castings with special properties, for example, tells how CWC's constant research and advanced engineering give life to new and better alloys that assure increased strength and greater resistance to wear, heat and corrosion. "One Source" also deals with the subjects listed below . . . and there are photographs of the broad range of castings made by CWC. It's a booklet that everyone interested in castings–either directly or indirectly–should read. Send for your free copy today!

Whatever Your Requirements

GO TO ONE SOURCE

CWC

CAMPBELL, WYANT AND CANNON
FOUNDRY COMPANY
Muskegon, Michigan

- Intricate Castings
- Castings with Special Properties
- General Purpose Castings
- Heat-Treated Castings
- Steel Castings
- Centrifugal Castings
- Castings in Limited Quantities
- Castings in Volume

NOW . . . a powerful electric STARTER FOR MIDGET TURBOJETS

Starting a lightweight turbojet engine, such as the 1000-pound thrust Fairchild J44, is never a problem with the rugged Model D62 starter developed by Jack & Heintz. This starter is an electric, direct cranking unit which has substantially bettered the starting time limitations established by the engine manufacturer.

Field Proven

The D62 starter is establishing an enviable operational record on the small J44 turbojet engines being used as wing-tip thrust assist power plants on Fairchild's C-123B Assault Transport. Modifications of the D62 are in use on other specialized applications including Solar's gas turbine driven a-c power pod installations on the Convair C-131B. In addition, a new higher speed starter extremely light in weight for small turboprop engines has been developed and is being engine tested.

Special Features

Features of the J&H Model D62 include: grounded, irreversible, series-wound, interpole-type motor; planetary reduction gearing with multiple disc torque limiter; and an automatic jaw meshing mechanism, providing quick-acting positive engagement.

This small power package or a modification of it engineered to your particular application may be the answer to your starting problem. Send for complete data including performance curves and dimensional drawings. Write Jack & Heintz, Inc., 17638 Broadway, Cleveland 1, Ohio. Export Dept.: 13 E. 40th St., New York 16, N.Y.

CHARACTERISTICS

Engine Mounting Pad	AND20002, Type XII-S (except opposite rotation)
Starter Input:	
Voltage, d-c	22-28
Current, amp (max)	450
Starter Output	30 lb-ft @ 800 rpm, 24 v
Gear Reduction	7:1
Torque Limiter:	
Breakaway Torque, lb-ft (max)	80
Slipping Torque, lb-ft (max)	65
Slipping Torque, lb-ft (min)	55
Jaw Teeth, number	3
Rotation, viewed from anti-drive end	Counterclockwise
Weight, lb (approx net)	25

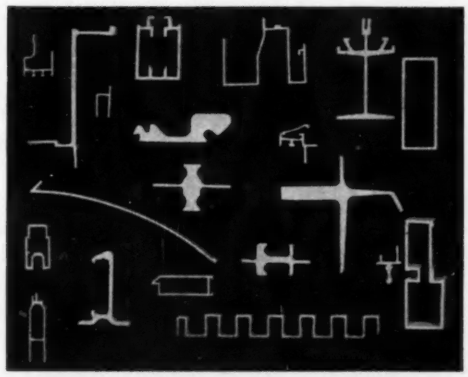
OPPORTUNITIES FOR ENGINEERS

There's a promising future for electrical and mechanical engineers at Jack & Heintz. Write Manager of Technical and Professional Placement, today, for illustrated, descriptive booklet.

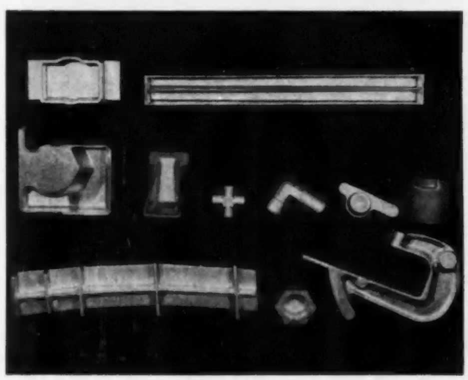
©1956 by Jack & Heintz, Inc.

JACK & HEINTZ *Rotomotive* AIRCRAFT EQUIPMENT

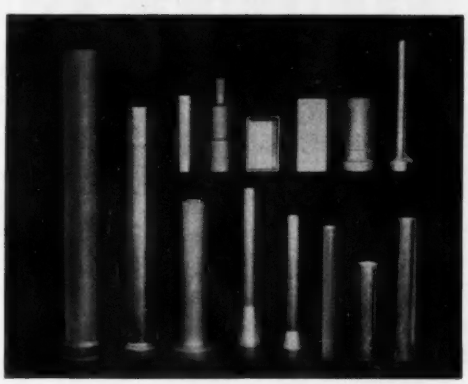
You can make it faster and better *with* Harvey Aluminum



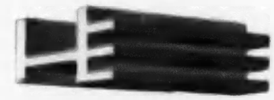
EXTRUSIONS . . . For decorative as well as basic parts, custom-designed aluminum extrusions replace riveted and welded assemblies . . . simultaneously adds strength, simplifies fabrication.



PRESS FORGINGS . . . Where parts must combine maximum strength with savings in weight, cost and manpower, Harvey aluminum forgings often completely solve the problems encountered by the designer.

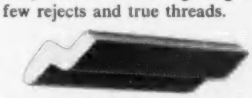


IMPACT EXTRUSIONS . . . Thin-walled, tubular structures can be produced by this method and held to very close tolerances. Machining is practically eliminated; scrap is greatly reduced.

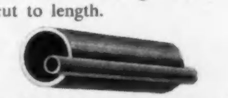


STRUCTURALS . . . High strength, light weight, workability, corrosion resistance. Aluminum extrusions combine all four . . . are ideal as basic load-bearing members.

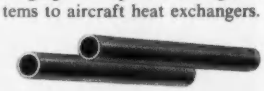
MACHINING STOCK . . . Harvey deep-drawn hex and round stock set a new mark in uniform grain structure—consistent from surface to core. This means fast, chatter-free cutting, long tool life, few rejects and true threads.



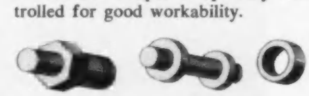
FORGING STOCK . . . If you make your own forgings in quantity, Harvey extruded forging stock can save many intermediate steps. Custom-designed extrusions whose cross sections approximate the forged blanks may be cut to length.



EXTRUDED PIPE AND TUBE . . . Seamless . . . uniform in structure, size and shape . . . clean and smooth inside and out . . . easily formed. Usable in applications ranging from portable irrigation systems to aircraft heat exchangers.



DRAWN TUBE . . . Combines strength and high finish . . . ideal for TV antennas, furniture, and similar products. Cold drawn for structural uniformity . . . and the temper is specially controlled for good workability.



SCREW MACHINE PRODUCTS . . . The West's largest installation of multiple-spindle screw machines can reduce your manufacturing costs. Harvey carries your job through from engineering to quality control.

Harvey is a leading independent producer of aluminum extrusions in all alloys and all sizes, special extrusions, press forgings, hollow sections, structurals, rod and bar, forging stock, pipe, tube, impact extrusions, aluminum screw machine products and related products. Also similar products in alloy steel and titanium on application.

MAKING THE MOST OF ALUMINUM . . . FOR EVERYONE

HARVEY Aluminum

HARVEY ALUMINUM SALES, INC.
TORRANCE, CALIFORNIA
BRANCH OFFICES IN PRINCIPAL CITIES

ENGINEERS
AND
SCIENTISTS

Diversification and Expansion of

CURTISS-WRIGHT RESEARCH DIVISION

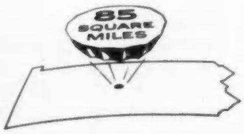
has created these

TOP LEVEL CAREER OPPORTUNITIES

Curtiss-Wright Corporation's rapid growth in commercial fields has created excellent positions for men of specialized ability. Expansion of the Research Division has called for the establishment of an 85-square-mile Research and Development Center at Quehanna, Pennsylvania.

As participants in such large scale activities, experienced engineers and scientists of broad vision and technical ability will find at Curtiss-Wright a variety of unusual, far-reaching professional opportunities where a man's future is limited only by his talents.

Curtiss-Wright also has numerous openings for engineering graduates not as yet qualified for these more advanced positions. Personnel benefits are many, and the company's research activities cover such products and projects as:



Quehanna, Pa.

New Research and Development Center providing the latest facilities for the advancement of gas turbine, ram jet, nuclear, rocket powerplants and for Curtiss-Wright's many diversified areas of research including electronics and ultrasonics.

Advanced Aircraft Powerplants

Applied research in gas dynamics and supersonic flow, combustion, fuels, mechanical design, metallurgy, new materials and new fabrication techniques to create the advanced components from which tomorrow's powerplants will be built.

Nuclear Power

Research into those aspects of nuclear physics, chemistry, electronics, radiation damage, heat transfer, fluid flow, metallurgy, new materials and processes which enter into the design of reactors and nuclear powerplants for the Government.

Electronics

Research on equipment having automatic controls, reactor control instruments and systems, radiation measuring and detection devices and similar equipment for industry.

Ultrasonics

Research on applications of ultra high frequency sound to food processing, materials inspection, parts cleaning, metal drilling and other industrial uses.

Designers and Development Engineers . . . to work on extremely lightweight rotating machinery; coordinate with other specialists engaged in related projects.

Metallurgists . . . for high stress, high temperature machinery. Cooperate closely with designers, shop and development personnel. Advise on materials and special fabrication methods in design stage. Interpret and remedy failures in experimental stage. Direct juniors and technicians in materials testing, welding, brazing, high-temperature alloy development, powder metallurgy.

Manufacturing Procurement Experts . . . to procure unusual experimental parts rapidly.

Nuclear Materials Scientists . . . to study basic properties of unusual materials, alloys, crystal structures, phase diagrams, radiation damage, corrosion, bonding problems, etc.

Nuclear Heat Transfer Engineers and Physicists . . . to assist in the design, analysis, and experimental work involved in developing heat transfer and fluid mechanics systems.

Theoretical Physicists . . . Conduct analysis and advanced design concept work for nuclear reactors, shielding and nuclear power systems.

Controls Engineers . . . for the design or development of aircraft engine and reactor controls. Capable of applying theory using electrical analogs; have practical experience in actual working of systems.

Advanced Compressor Engineers... for the aerodynamic development of transonic and supersonic compressors. Others, experienced in supersonic wind tunnel work and cascade blade design and research.

Combustion and Fuel Engineers... for work upon high heat combustion chambers in advanced aircraft and missile powerplants. Thorough knowledge of aerodynamics and fuels chemistry.

Propulsion Analysis Engineers . . . engineers, aerodynamicists, mathematicians, physicists for advanced analysis, operations research and diagnostic technical work in the fields of performance, controls and systems applications in advanced propulsion and power.

Nuclear Reactor Design Engineers . . . Mechanical, with extensive experience in the design of nuclear reactors.

Bearing and Lubrication Engineers . . . for the design and development of machinery incorporating high speed, high-load and high temperature bearings, seals, gears.

Vibration Engineers . . . experienced in the use of current instrumentation to analyze vibration characteristics of complex rotating and stationary parts.

Stress Analysts . . . seniors, with ability to eliminate stress concentrations in minimum weight applications while in the design stage. Aircraft powerplant experience.

Mathematicians . . . work on scientific and technical problems requiring the use of digital and analog computers, e.g. IBM 701, 704 and REAC machines.

Nuclear Engineers . . . Mechanical, Chemical, Electrical, Sanitary, Industrial, Aeronautical, others to join a strong nucleus of engineers and scientists in the research and development of nuclear powerplants. Some experience in the nuclear field required.

Nuclear Manufacturing Engineers... Experienced in fabrication and manufacturing fields associated with nuclear reactor and atomic energy. Knowledge required: handling unusual materials, brazing, welding, forming, toxicity problems, accountability procedures.

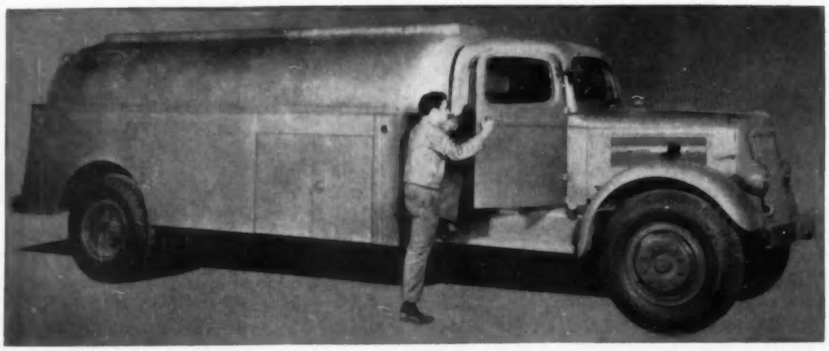
Ceramics Engineers . . . with practical experience in the design and experimental development of new materials for a variety of applications.

For appointment for interview

Personal, confidential interviews will be arranged upon receipt of typewritten resumes, giving complete details of education and past experience.

Address: S. H. BOGACZYK, Industrial Relations Manager, Department T-5

RESEARCH DIVISION
CURTISS-WRIGHT
CORPORATION • CLIFTON, NEW JERSEY



Deadweight was reduced 600 lbs. in the shell of this metropolitan delivery truck-tank unit through the use of Mayari R. The tank, which was built for an oil company in California by the Independent Iron Works, Oakland, was made of 12-gage Mayari R sheets and weighs 3200 lbs. The capacity of the tank is 2200 gal.

This fleet of 2-ton trucks holds down both operating and maintenance expenses, thanks to reduced deadweight in bodies built of Mayari R by Leonhardt Body Division of Charles T. Brandt, Inc., Baltimore, Md. Furthermore, life of truck bodies is greatly extended by the corrosion-resistance of Mayari R, a high strength, low alloy nickel steel, produced by Bethlehem Steel Co., Bethlehem, Pa.

Nickel alloy lengthens truck body life ...allows 15% weight reduction

These truck bodies are made from Mayari R...a high strength, low alloy steel containing nickel.

Its use in these bodies enabled the builder to cut deadweight approximately 15 per cent. Because thin, light sections of this type steel provide the same strength as thicker, heavier sections of plain carbon steel.

What's more, Mayari R and similar high strength, low alloy nickel steels offer 5 to 6 times the corrosion resistance of carbon steel in atmosphere. And 2 to 4 times that of copper bearing steel.

As a result, these steels retain most of their original section thickness and hence their original strength during years of use. This means less maintenance ... and greatly lengthened equipment life. Their resistance to impact and abrasion is also superior to that of carbon steels.

Get the facts...send for a copy of "Nickel-Copper High-Strength Low-Alloy Steels." Cover-to-cover, it's full of valuable data. It tells you how these nickel steels perform on a variety of jobs...their response to fabrication ... and design factors that can help you cut deadweight. Write for your copy now and learn how these steels can save you money.

INCO TRADE MARK **THE INTERNATIONAL NICKEL COMPANY, INC.** 67 Wall Street New York 5, N.Y.

LONG

DESIGNS AND MAKES THEM BETTER

HEAT EXCHANGERS
RADIATORS
TORQUE CONVERTERS
CLUTCHES

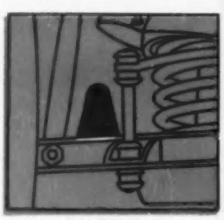
ENGINEERING
B-W
PRODUCTION

LONG MANUFACTURING DIVISION
BORG-WARNER CORPORATION
12501 DEQUINDRE STREET
DETROIT 12, MICH.—WINDSOR, ONT.

Just published... New brochure on Long's complete line... Write for your copy

In over 100 places, **Enjay Butyl rubber parts**

add to Pontiac performance

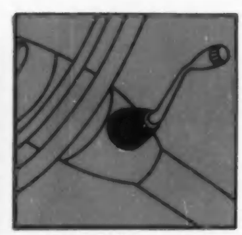


Axle bumper

Body seals, gaskets, insulators, pads, grommets, etc.

Brake and accelerator pedal pads, bellows

Radiator and heater hoses, ducts



Gearshift lever cover

Pontiac has been using parts made of Enjay Butyl since 1946. The great '56 model now incorporates more than 100 parts made from this super-durable rubber, adding to its performance, style and value. These parts have amazing resistance to deterioration and will easily last the life of the car.

Among the many advantages of Enjay Butyl are *price* and *ready availability*. And it is now available in non-staining grades for white and light-colored parts. Extensive laboratory and testing facilities are at your service. For the full story, contact the Enjay Company today.

ENJAY BUTYL

Enjay Butyl is the super-durable rubber with *outstanding* resistance to aging • abrasion • tear • chipping • cracking • ozone and corona • chemicals • gases • heat • cold • sunlight • moisture

ENJAY

ENJAY COMPANY, INC., 15 West 51st Street, New York 19, N. Y.
District Office: 11 South Portage Path, Akron 3, Ohio

36 SUCCESSFUL YEARS OF LEADERSHIP IN SERVING INDUSTRY

It's good business to equip your trucks with the AIR BRAKES America's leading fleet operators prefer—BENDIX-WESTINGHOUSE!

MR. CLARENCE A. GARRETT
President and General Manager
Garrett Freightlines, Inc.

For 42 years, Mr. Garrett has directed activities of this pioneer motor carrier from offices in Pocatello, Idaho, birthplace and still general headquarters of the firm. Last year, in nine Western states, nearly 1,000 Garrett units rolled 24 million miles over all kinds of highways in all kinds of weather. Winner of ATA's 1954 National Truck Safety Contest in the over-20-million-miles class, Garrett Freightlines has received numerous other awards for outstanding performance through the years. Mr. Garrett, the manager of America's safest carrier says:

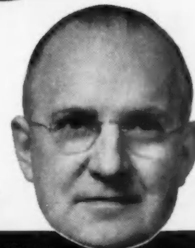
"In our 42 years in business

We've bought 3,000 trucks

AND WHEN IT COMES TO AIR BRAKES, WE PREFER

Bendix-Westinghouse!"

THE WORLD'S MOST TRIED AND TRUSTED AIR BRAKES



MR. J. F. ERNSTHAUSEN
President, Norwalk Truck Line Company

From his company's home office in Norwalk, Ohio, Mr. Ernsthausen directs a dynamic motor carrier organization, numbering 3300 employees, whose [illegible] power units and [illegible] semi-trailers compile a total average of some 52,000 individual shipments each week! Norwalk Truck Line maintains 39 complete service terminals located in the principal cities of northern Ohio, Michigan, western Pennsylvania and northern Indiana as well as in Chicago, Illinois. Mr. Ernsthausen, one of the Midwest's best-known fleet executives, states . . .

"During our 33 years in business

We've bought 2,000 trucks

AND WHEN IT COMES TO AIR BRAKES, WE PREFER

Bendix-Westinghouse!"

THE WORLD'S MOST TRIED AND TRUSTED AIR BRAKES

For twenty-five years Bendix-Westinghouse Air Brakes have been the first choice of truck manufacturers and truck operators everywhere, consistently outselling all other makes of air brakes combined. In fact, recognition of the greater safety, economy and dependability of Bendix-Westinghouse Air Brakes by truck buyers has resulted in their factory installation on an ever increasing number of truck models of all sizes.

Chances are good that your trucks, too, offer the many advantages of these powerful brakes. If not, we suggest that you take advantage of the proven preference and superiority of Bendix-Westinghouse Air Brakes by offering them as factory-installed equipment. It's one sure and easy way to add more sales appeal to your vehicles!

Over 1,500,000 compressors produced over a twenty-five-year span stand behind the TU-FLO 400. Many advanced features guarantee performance no other compressor can equal.

Bendix-Westinghouse AIR BRAKES

BENDIX-WESTINGHOUSE AUTOMOTIVE AIR BRAKE COMPANY • General offices and factory—Elyria, Ohio. Branches—Berkeley, Calif. and Oklahoma City, Okla.

Industry's Widest Range

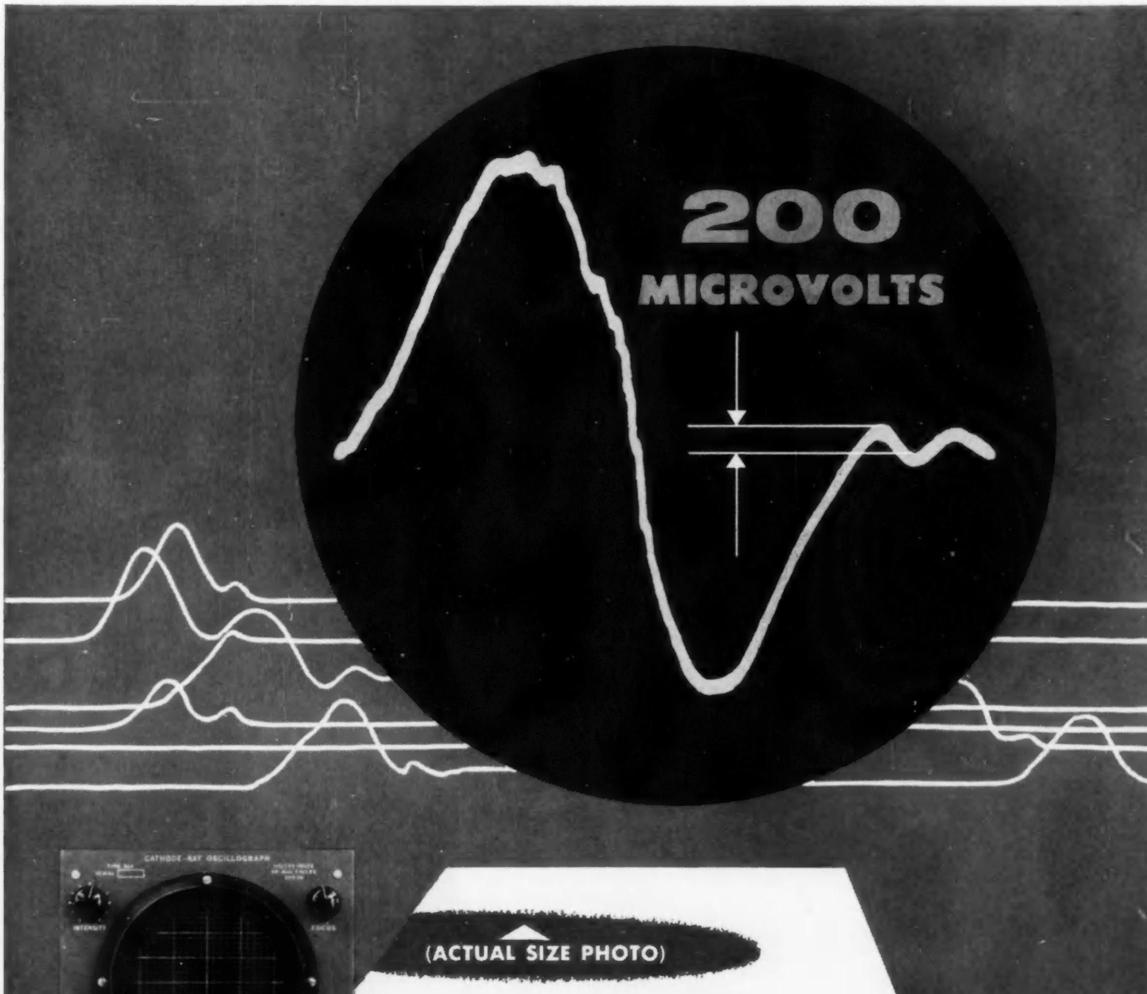
•• OF SLEEVE BEARING TYPES & SIZES

In this photo you will find a Johnson Sleeve Bearing of every type used in industry. Various alloys . . . bronze, babbitt or aluminum . . . can be selected . . . and different combinations with bronze or steel are available. Johnson Bronze facilities make possible a size range from tiny bearings up to King Size, 14" OD, 17 inches in length. Since Johnson Bronze produces all the types of sleeve bearings, their engineers can give you unbiased advice on the bearing best suited to your application.

JOHNSON BRONZE COMPANY
550 South Mill St. • New Castle, Pennsylvania

JOHNSON BEARINGS
Sleeve-Type

Write for Information or for an appointment to discuss your problems.


200
MICROVOLTS
(ACTUAL SIZE PHOTO)
DUMONT
. . . and this amazing sensitivity is only one of many outstanding characteristics of the entirely new DuMont Type 324 cathode-ray oscillograph. New standards of stability, low noise and hum level assure full use of the Type 324 for d-c to 300 kc measurements even in the microvolt region. Furthermore, the Type 324 is completely calibrated to read time and amplitude directly. There are so many features incorporated in this new instrument we can't begin to give you the whole story here. Write us for complete specifications, or better still, ask for a demonstration of the
NEW DUMONT TYPE 324
For further information write to:
Technical Sales Department • ALLEN B. DU MONT LABORATORIES INC. 760 Bloomfield Ave., Clifton, N. J.

The picture you see here is really two things.

First of all, it's a picture of the newly completed buildings of Aluminum Industries, Inc., showing the greatly expanded research, development and production facilities now spread over 40 acres on Werk Road, Cincinnati.

But more than that, it's a picture of faith—faith by the Management of Aluminum Industries, Inc. in the present and the future of the automotive industry.

Great as are the achievements of the automotive industry today, the industry is headed for a much greater tomorrow, to meet the needs of our rapidly increasing population. Your repeated announcements of new plants, new research, and greater capital investments prove your vision of the future.

Because we at Aluminum Industries, Inc. share this faith and vision, we too have laid plans for tomorrow . . . plans which are now a reality.

Aluminum Industries, Inc. has long been a major supplier of pistons, valves and other precision parts to the automotive industry. *Practically every car you see today contains some part made by Aluminum Industries, Inc.*

We, the Management of Aluminum Industries, Inc., wish to express our appreciation for the increased business you have given us and for the confidence you have placed in us.

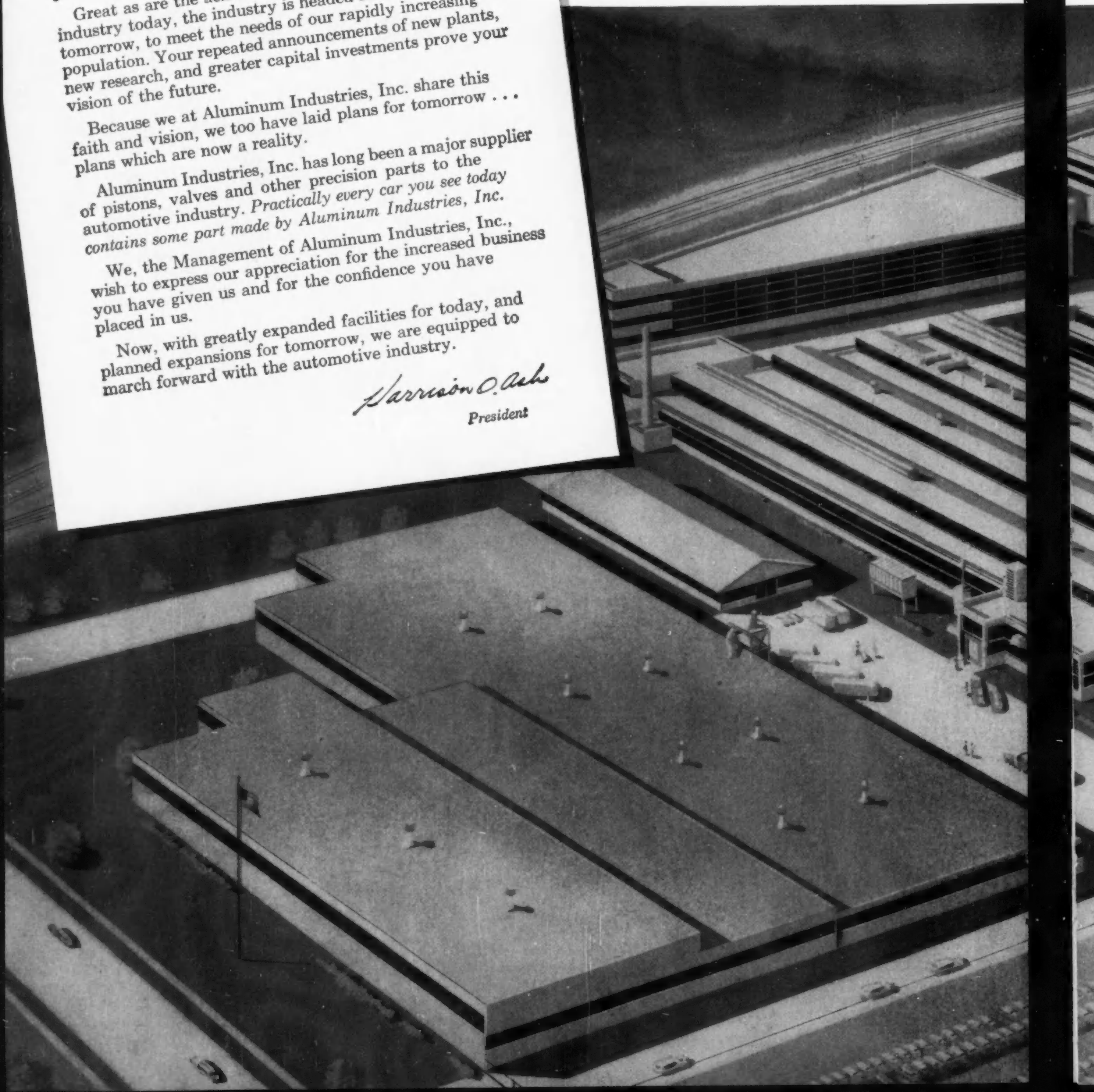
Now, with greatly expanded facilities for today, and planned expansions for tomorrow, we are equipped to march forward with the automotive industry.

Harrison O. Ash

President

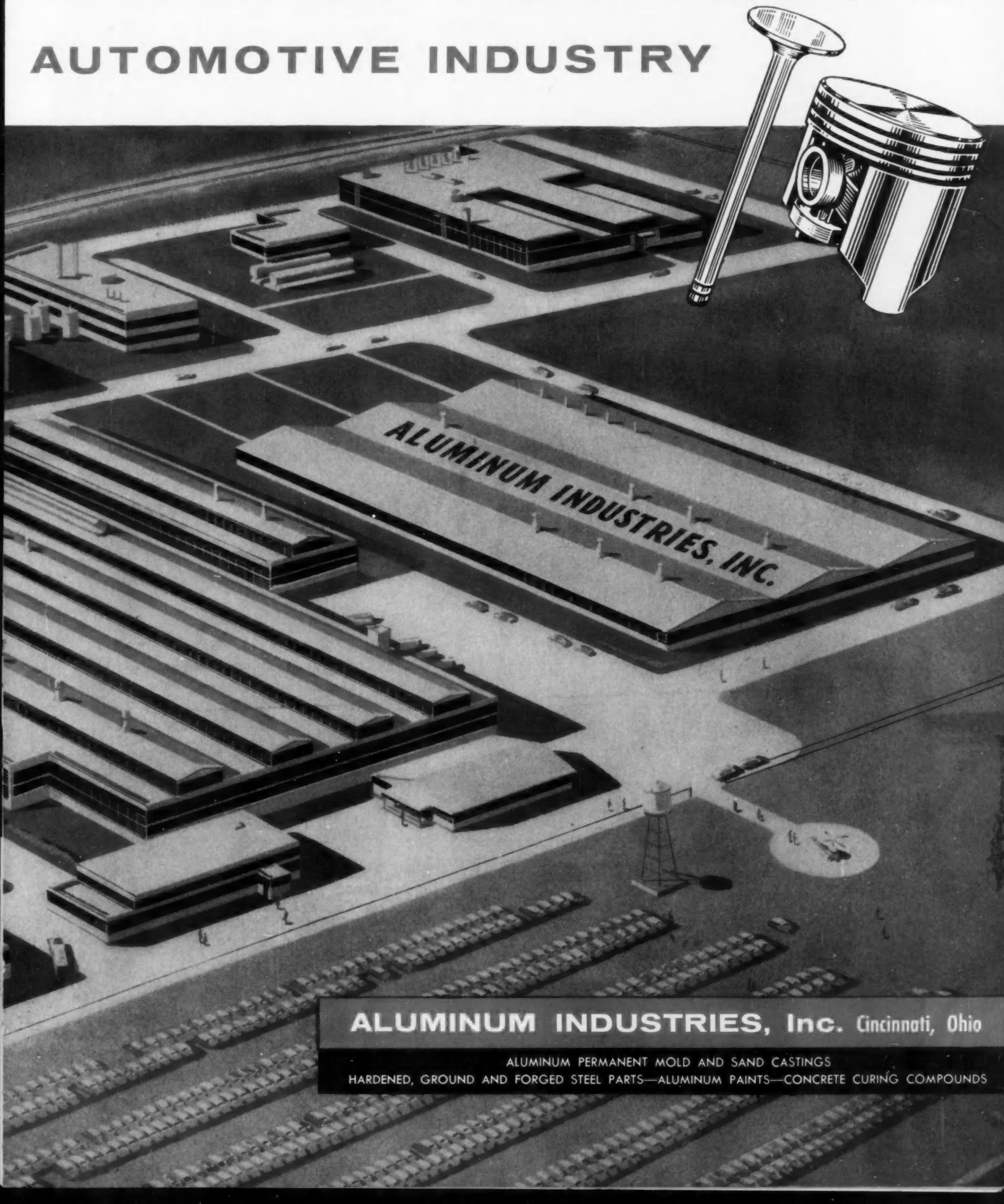
. . *a message from*

to the



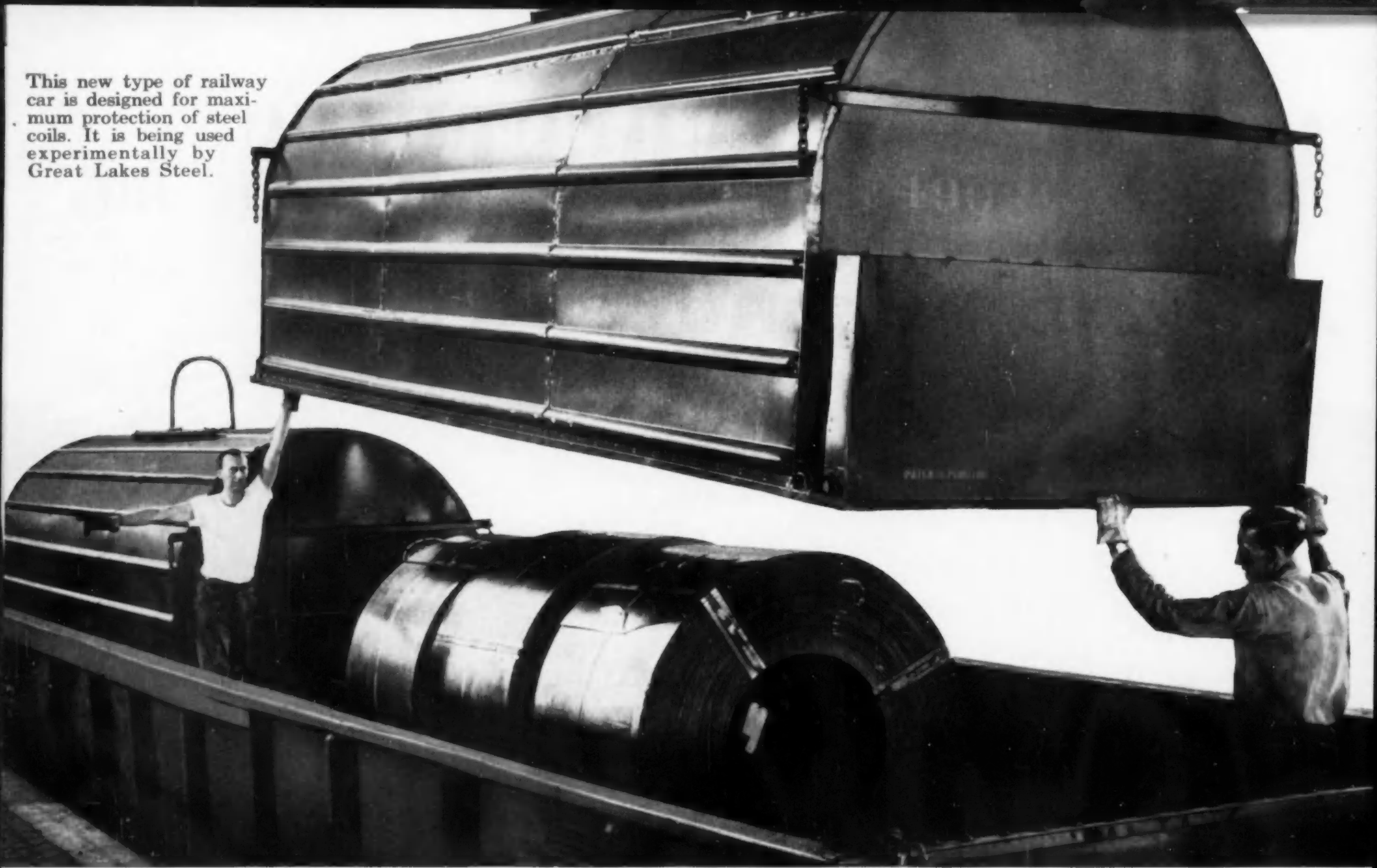
ALUMINUM INDUSTRIES, Inc.

AUTOMOTIVE INDUSTRY



ALUMINUM INDUSTRIES, Inc. Cincinnati, Ohio

ALUMINUM PERMANENT MOLD AND SAND CASTINGS
HARDENED, GROUND AND FORGED STEEL PARTS—ALUMINUM PAINTS—CONCRETE CURING COMPOUNDS



This new type of railway car is designed for maximum protection of steel coils. It is being used experimentally by Great Lakes Steel.

How Great Lakes Steel *delivers* quality

Another order receives individual attention as sheets of steel are wrapped with a waterproof covering and banded to meet the customer's specifications.

Steel coils (below) are securely blocked on a truck and trailer at Great Lakes Steel. Heavy tarpaulin cover is provided by truckers as standard equipment for additional protection.

The emphasis on quality at every stage of production at Great Lakes Steel extends right on through to the Delivery Department. There, careful attention is given to handling and packaging each coil and bundle to make sure that the customer receives his order in prime condition.

The Delivery Department has another important responsibility, too. It must see that our products reach each customer in ample time to meet his production schedules.

For quality with service—that extends all the way from the beginning of our operations to the end of yours—call on Great Lakes for your flat-rolled steel requirements.

GREAT LAKES STEEL CORPORATION

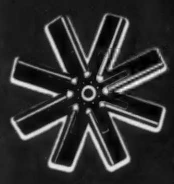
Ecorse, Detroit 29, Michigan • A Unit of

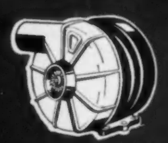
NATIONAL STEEL CORPORATION

District Sales Offices: Boston, Chicago, Cincinnati, Cleveland, Grand Rapids, Houston, Indianapolis, Lansing, Los Angeles, New York City, Philadelphia, Pittsburgh, Rochester, St. Louis, San Francisco, Toledo, Toronto.

Specialists for over 37 Years in

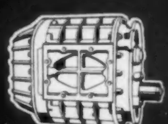
FLUID FLOW and VIBRATION DAMPING PRODUCTS


Fans


Turbochargers

Schwitzer has extensive Research and Engineering facilities and experienced technicians to develop an economical product—for the Flow of Air, Oil, Water and other Fluids—or the Isolation or Elimination of Vibration in your equipment, whether it is in the Automotive, Atomic, Aircraft, Agricultural, Earth Moving, or other fields.


Dampers


Superchargers

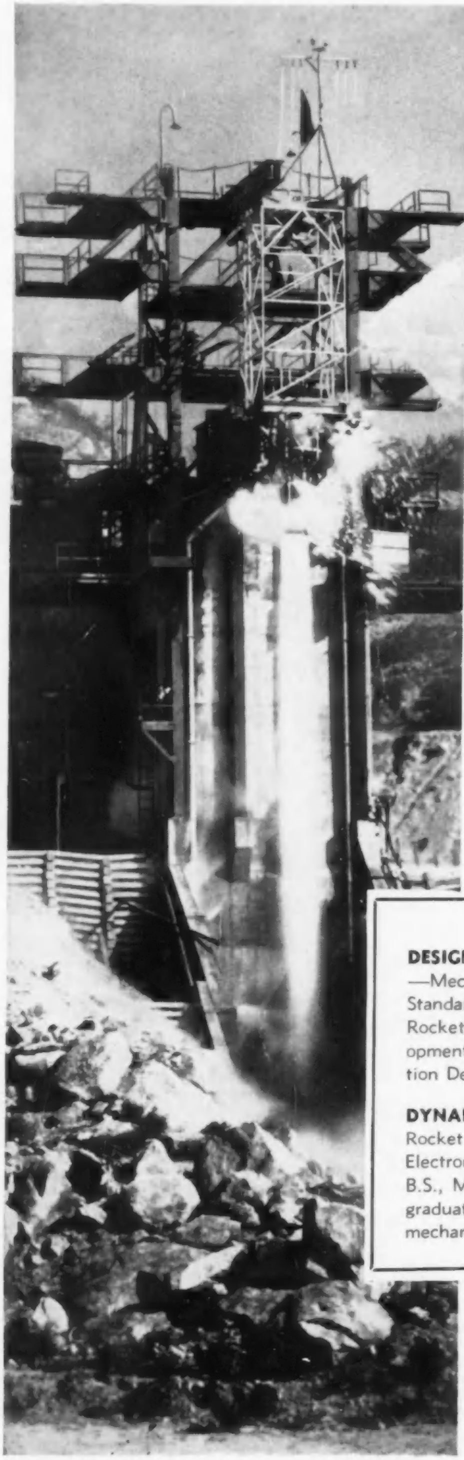
Schwitzer utilizes the most modern production facilities for the Fabrication, Assembly and Testing of these Precision Products—for high or low volume production.


Water Pumps


Oil Pumps

These services are available to you for product development applications in many diversified fields.

SCHWITZER CORPORATION
INDIANAPOLIS, INDIANA



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Rocketdyne Offers

CAREERS FOR ENGINEERS IN ROCKET ENGINES

NOW, you can check on positions in the engine industry with an assured future—rocket engine design and development. North American . . . the company that has built more airplanes than any other company in the world . . . is also a pioneer in rocket engine design and development. Today, North American is the acknowledged leader in large liquid rocket engines.

YOU can be part of this success . . . team up with the top engineers in rocket engine design and development. Your ideas and work are given unusual recognition at North American . . . our liberal Patent and Suggestion Award Programs prove this. A fine Retirement Plan and other personal benefits are yours also at North American.

Assure your future now. You can work at Rocketdyne's Propulsion Test Laboratory in the Santa Susana Mountains or at Rocketdyne headquarters in the new, multi-million-dollar plant now built in beautiful Canoga Park in Southern California's fabulous San Fernando Valley.

THESE POSITIONS NOW OPEN AT ROCKETDYNE:

DESIGN & DEVELOPMENT ENGINEERS—Mechanical, Chemical, Electrical, Standards, Structural and Stress. For Rocket Engine Systems Design or Development—Turbine, Pump and Combustion Device experience preferred.

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EQUIPMENT DESIGN ENGINEERS—Electrical, Mechanical, Structural.

ELECTRONICS TECHNICIANS

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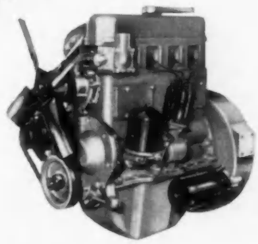
A DIVISION OF NORTH AMERICAN AVIATION, INC.

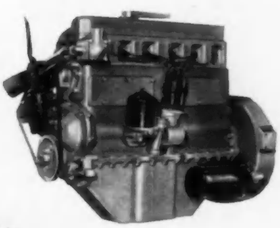
HERCULES *announces new models*

4 CYL.

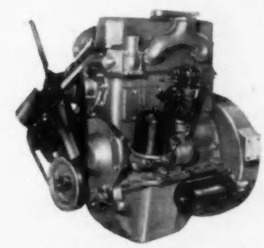


G. O. SERIES
GASOLINE OVERHEAD VALVE
Also available for L. P. G., Kerosene and Natural Gas

6 CYL.

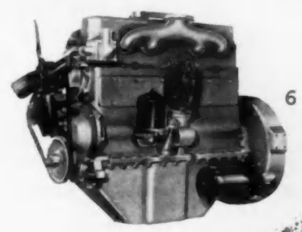


4 CYL.



D. D. SERIES
DIRECT INJECTION DIESEL

6 CYL.



Additions to the extensive line of **Hercules Engines**

With the addition of these four new series consisting of 12 models, the Hercules Motors Corporation has increased its line of engine sizes and types to better serve the varied needs of the many different industries which require gasoline and diesel engines for their power requirements. This expansion of the Hercules line will enable manufacturers of end products to have a wider selection of engines and power units to meet individual requirements, all available from one dependable source.

Mounting dimensions of the new G.O. gasoline and D.D. diesel four cylinder engines are the same. The G.O. gasoline and D.D. diesel six cylinder engines are also interchangeable from the standpoint of mounting dimensions. Since this new series consists of parallel lines of gasoline and diesel engines, they can be used interchangeably, if desired, in any end product within the recommended engine speed ranges. Further, these engines can be built with manifolds and accessory equipment on either side, as the cylinder blocks are symmetrical and can be turned end for end.

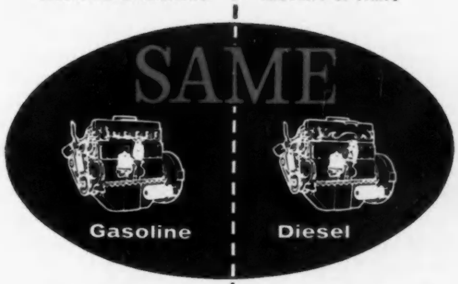
Another important feature of these new models is the great number of parts which are interchangeable between the fours and sixes, and also, between the gasoline and diesel. This greatly simplifies the parts and service requirements. The only essential differences between these gasoline and diesel engines are cylinder heads, manifolds, pistons and fuel handling equipment.

Further information on the G.O. and D.D. series may be obtained by writing the factory.

Engine Manufacturing Specialists Since 1915

INTERCHANGEABLE

MOUNTING DIMENSIONS | MAJORITY OF PARTS



G.O. 4 CYL.

Model	Max. H.P..
G.O. 173	67 @ 3200 R.P.M.
G.O. 198	76 @ 3200 R.P.M.
G.O. 226	87 @ 3200 R.P.M.

D.D. 4 CYL.

Model	Max. H.P.
D.D. 173	50 @ 2000 R.P.M.
D.D. 198	57 @ 2000 R.P.M.
D.D. 226	65 @ 2000 R.P.M.

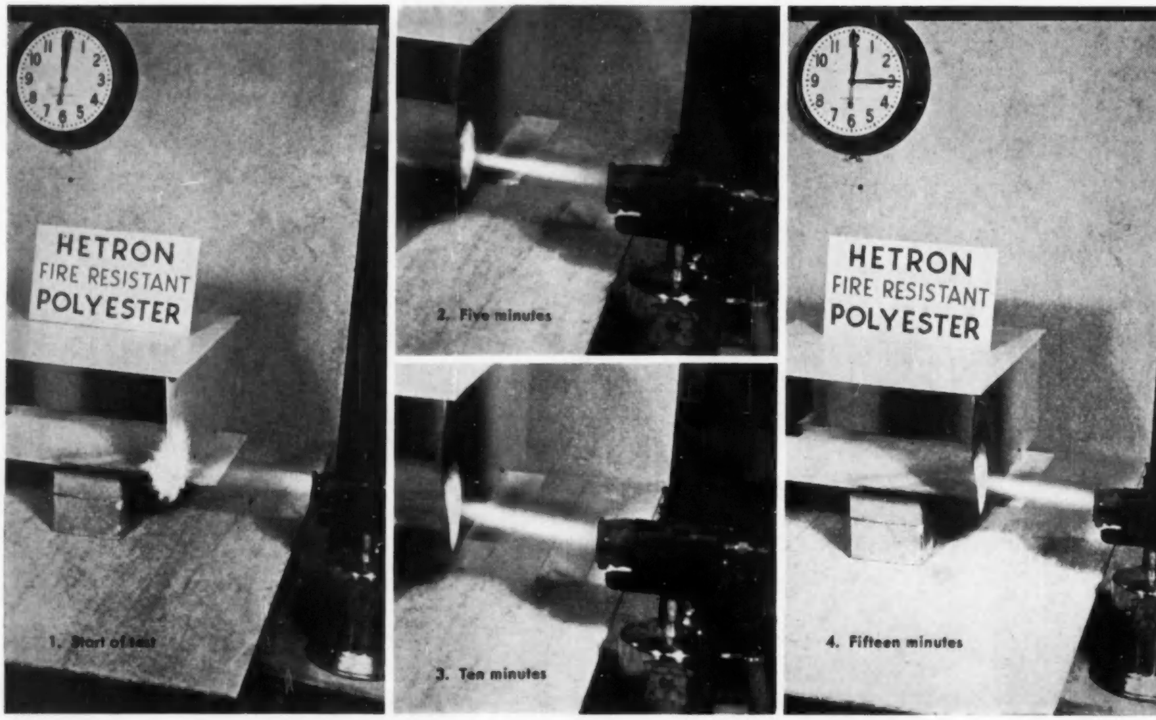
G.O. 6 CYL.

Model	Max. H.P.
G.O. 260	102 @ 3200 R.P.M.
G.O. 298	114 @ 3200 R.P.M.
G.O. 339	131 @ 3200 R.P.M.

D.D. 6 CYL.

Model	Max. H.P.
D.D. 260	75 @ 2000 R.P.M.
D.D. 298	85 @ 2000 R.P.M.
D.D. 339	99 @ 2000 R.P.M.

HERCULES MOTORS CORPORATION • CANTON, OHIO



BLOWTORCH FLAME plays steadily on HETRON test structure for 15 minutes; can't start it burning.

New material for idea-men: **fire-resistant polyesters**

Want to engineer high strength plus *specific fire resistance* into a product? Take a hard look at HETRON® polyester resins.

You can use HETRON in many places where reinforced polyesters have not been practical heretofore. HETRON will not burn, except at the point where a hot flame is directly applied. It "snuffs out" as soon as the flame source is removed.

In exploratory tests, sheets of HETRON have shown flame spreads as low as 20 by ASTM E84-50T (Tunnel Test)—compared with ratings of 0 for asbestos board and 100 for red oak.

The versatile "family" of HETRON resins can be modified and blended by the fabricator, to make possible a whole galaxy of controlled physical properties. These resins combine fire resistance with outstanding flexural strength, tensile strength, heat resistance, and very low water absorption. Using light-stabilized HETRON, you can attain excellent resistance to weathering.

Some HETRON resins, including semi-rigid HETRON 32A, are manufactured to meet Military Aircraft Specification MIL-R-7575A, Types I and II. HETRON 92, with up to 10% added styrene, meets MIL-R-7575A, Types I, II, III.

New as it is, HETRON is already proving its merit in automobile and truck body panels and structural members; aircraft parts; large boat hulls; machine housings; radomes; electrical insulating board and parts; chemically resistant blowers, tanks and ductwork; "sandwich" structural and refrigeration panels; skylights, louvers, and industrial windows.

Is there a place in your designs for this unique combination of strength-plus-safety? To find out, write today for complete data file on HETRON resins.

Ask also for names of fabricators who can supply you with HETRON parts.

Comparative Physical Characteristics

HETRON and 10 non-fire-resistant resins

Physical Property		Rigid Resins		Semi-rigid Resin
		HETRON 92	Avg. 10 Others	HETRON 32 A
Flexural Strength, PSIx10³	Room Temp.	38.6	36.4	41.8
	180°F.	25.0	18.6	23.5
Flexural Modulus, PSIx10⁶	Room Temp.	1.88	1.61	1.82
	180°F.	0.90	0.79	0.85
Tensile Strength, PSIx10³		21.7	22.0	21.0
Water Absorption, Pct. by Wt.		0.13	0.29	0.13

SUPERIOR PHYSICALS of HETRON show up in exhaustive tests by independent, impartial laboratories. Panels 0.1" thick, made from HETRON and 10 leading non-fire-resistant resins, contained 35-40% glass mat, 17-20% filler, and the balance resin. Note that HETRON 32A, a semi-rigid resin, is compared with non-fire-resistant *rigid* resins.

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From the Salt of the Earth

HOOKER ELECTROCHEMICAL COMPANY

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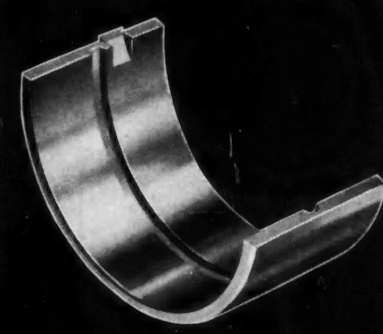
for
the leaders
in new
engine design

Detroit
Aluminum
and
Brass

ENGINE BEARINGS

You can rely on the same research that conceived, designed and developed the now famous and much imitated *Thin-Wall Babbitt bearing.

*U.S. PAT. NO. 2173985



We can meet high production needs or special requirements for bearings and bushings of every type used in original equipment.

Steel backed, copper lead and aluminum alloy-lined bearings are lead-tin overplated to customer's specifications.

Tell our engineers about your requirements

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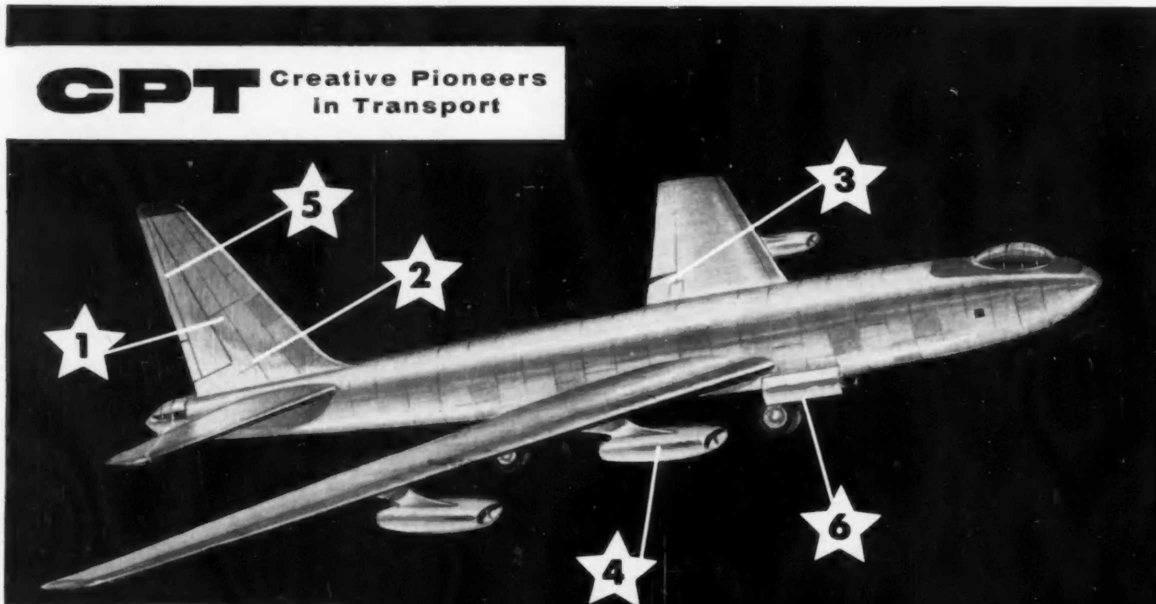
DETROIT 11, MICHIGAN

Plants at Detroit, Michigan and Bellefontaine, Ohio



1 CPT Stabilizer Control Actuator

2 CPT Structural Fin Fitting

3 CPT Ball-screw Flap Actuator

4 CPT Afterburner Actuator

5 CPT Rudder Control Actuator

6 CPT Landing Gear

CPT STARS IN AIRCRAFT LANDING GEAR ACTUATORS AND STRUCTURAL COMPONENTS

More aircraft rely on CPT Landing Gears than all other makes combined.

More vital aircraft equipment is operated by CPT ball-screw mechanisms than all other makes combined.

CPT has a unique combination of experiences. Engineering and production facilities have led all the top aircraft builders in bringing their designs to CPT. They rely on CPT for finished assemblies on schedule.

You can count on CPT's experience as the pioneer in landing gears. And the leading producer of all types of ball-screws. And the outstanding designer of actuators. You can also make good use of CPT's outstanding facilities for large-scale resistance welding, heat treatment, Kellering, and special machining. Call us before you begin your project.

CPT

CLEVELAND PNEUMATIC

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CPT Abilities and Facilities Assure the finest in Precision Performance

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WAUKESHA

MODEL	Cyl.	*Features	Bore and Stroke	Displ. Cu. In.	Max. Torque @ RPM	Max. HP	RPM
TURBO-SUPERCHARGED DIESELS							
135-DKBS	6	ACTV	4¼x5	426	400-1800	185	2800
148-DKBS	6	ACTV	5¼x6	779	706-1800	280	2100
WAKDBS	6	ACTV	6¼x6½	1197	1062-1600	352	1800
NORMAL DIESELS							
185-DLC	6	A	3½x3¾	216	152-1200	60	2400
190-DLCA	6	AC	3¾x4	265	191-1400	85	2800
195-DLCA	6	AC	4 x4	302	221-1800	98	2800
135-DKB	6	ACV	4¼x5	426	328-1600	147	2800
148-DKB	6	ACV	5¼x6	779	584-1000	200	2100
WAKDB	6	ACV	6¼x6½	1197	845-1000	258	1800
GASOLINE							
185-GLB	6	A	3½x3¾	216	176-1400	67	2400
190-GLB	6	A	3¾x4	265	220-1200	77	2400
195-GKA	6	ACV	4⅛x4	320	243-1600	122	3000†
MZA	6	A	4¼x4¾	404	289-1000	128	2800†
135-GKB	6	ACV	4¼x5	426	337-1200	147	2800†
135-GZB	6	ACV	4⅜x5	451	354-1200	153	2800†
140-GKB	6	ACV	4½x5½	525	425-1000	177	2600†
140-GZB	6	ACV	4⅝x5½	554	448-1100	188	2600†
145-GKB	6	ACV	5¼x6	779	595-1000	240	2400†
145-GZB	6	ACV	5⅜x6	817	630-1100	250	2400†
WAKB	6	ACV	6¼x6½	1197	1000-1000	280	1800

***FEATURES:** **A**—Aluminum Alloy Pistons; **C**—Counterbalanced Crankshaft; **T**—Turbo-Supercharged; **V**—Vibration Dampner.

†These engines rated at higher hp and rpm for fire engine service. *Send for Bulletin 1079 for LPG ratings and complete listing of engine hp and speed ratings.*

WAUKESHA MOTOR COMPANY • WAUKESHA, WIS.
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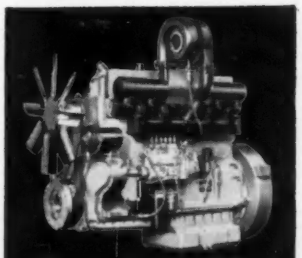
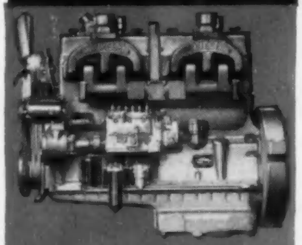
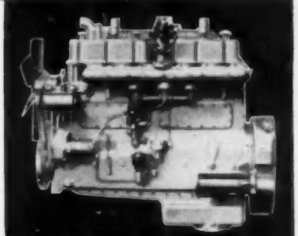
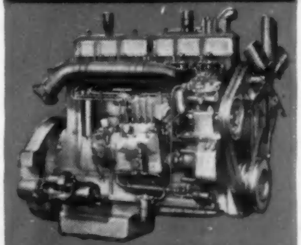
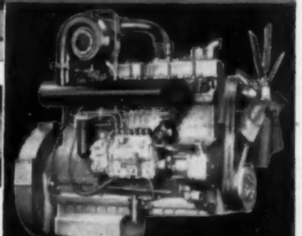
280-R

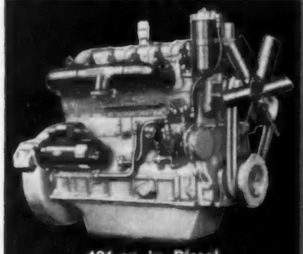

1197 cu. in. Supercharged Diesel


1197 cu. in. Diesel

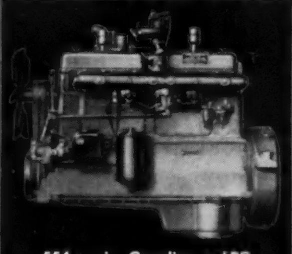

817 cu. in. Gasoline or LPG

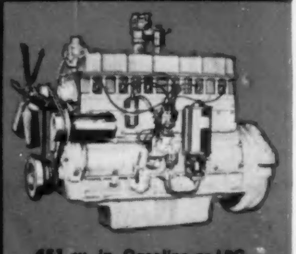

779 cu. in. Diesel


779 cu. in. Supercharged Diesel


426 cu. in. Diesel


426 cu. in. Supercharged Diesel


554 cu. in. Gasoline or LPG


451 cu. in. Gasoline or LPG

new clutch is adaptable to all torque needs

* Torque capacity of the new Lipe Direct Pressure Clutch can be modified by removing springs in multiples of three. For example: depending on its service, a 15" DP may require its full complement of 27 springs . . . or no more than 24, 21, 18, or 15.

The economies permitted by "de-springing" are obvious. Manufacturers can now carry a smaller stock of assorted clutches without sacrificing flexibility on the assembly line. Fleet Owners will notice significant reductions in maintenance since clutches won't be under- or overloaded.

Five sizes of Lipe's Direct Pressure Clutch — for engines developing from 300 to 1300 ft-lb of torque — now available. Write for complete details.

Manufacturers of Automotive Clutches & Machine Tools

LIPE ROLLWAY

Lipe-ROLLWAY CORPORATION SYRACUSE 1, N. Y.

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STANDARD-SIZED ROLLED-THREAD SAGINAW Ball/Bearing SCREWS PRICED AS LOW AS, OR LOWER THAN, ORDINARY ACME SCREWS!

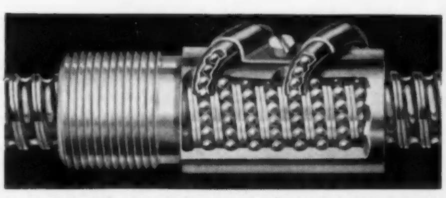
Get up to 6 times more efficiency... save at least 2/3 on power requirements or manual effort!

Here's great news for every manufacturer who uses Acme screws or hydraulic actuators in his product! Saginaw now offers Rolled-Thread *Safety b/b Screws* in standard sizes at amazingly low mass-production cost.

In many applications this new rolled-thread type will provide completely adequate performance at a fraction of the cost of machined-thread units.

GIVE YOUR PRODUCTS THESE PERFORMANCE ADVANTAGES AT NO INCREASE IN COST—

- **At least 90% efficiency guaranteed**—compared with 15% to 20% efficiency of Acme screws.
- **Requires less than 1/3 as much torque** as Acme screws for same amount of lineal output.
- **Saves substantially on cost, size and weight** of motors, gear boxes and auxiliary equipment.
- **Far less wear—less maintenance—longer life.**
- **Precision positioning**—free play can be virtually eliminated where necessary.
- **Operates dependably with or without lubrication** at temperatures from −75° F. to +175° F.



New standard Saginaw ball-nut can be furnished threaded or with flange or trunnion-type adaptors for easy application to almost any unit.

ROLLED-THREAD *SAFETY b/b SCREWS* CAN BE MANUFACTURED IN THESE STD. SIZES AND ANY SCREW LENGTH:

Ball Circle Diameter	Ball Size	Lead
.375	.0625	.125
.631	.125	.200
1.000	.15625	.250
1.171	.28125	.41304
1.500	.34375	.47368
2.250	.375	.500
3.000	.500	.660

ROLLED-THREAD *SAFETY b/b SCREWS* ARE ALREADY BEING SUCCESSFULLY USED IN THESE TYPICAL APPLICATIONS:

- Automatic Garage Doors
- Automobile Seat Adjusters and Window Lifts
- Barber Chairs
- Bumper Jacks
- Circuit Breakers
- Convertible Top Lifts
- Die Table Positioners
- Drill Presses
- Marine Steering Gears
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Saginaw Steering Gear Division
General Motors Corporation
Dept. 9E, Saginaw, Michigan

Please send detailed data on your new Rolled-Thread *Safety b/b Screws*. I am interested in their application to:________

Name—Title________

Firm________

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City________Zone____State________

Mail coupon today for full details and engineering recommendations for your needs.

Safety ball bearing Screw by Saginaw

For ROUGH TOUGH HARD going

SENIOR CONTOUR NO. 1893

Cushion Seats

MILSCO BRINGS YOU NEWEST ADVANTAGES IN SEATING COMFORT AND DURABILITY

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With or Without Fore and Aft Attachment

Improved driver-comfort is one of today's major engineering objectives . . . and Milsco can help you to step up the man-work-factor of your equipment with job-fitted cushion seating. Milsco Cushion Seats are the developments of years of experience in designing and manufacturing heavy duty cushion seats for all types of mobile equipment. Our field studies of enduring cushioning materials and contour body support may prove of important value to you. Write us about your seating problem now.

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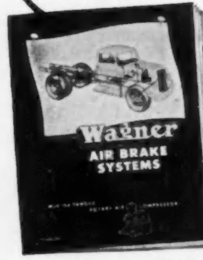

The system with the Rotary Air Compressor. They give added brake efficiency on all trucks, tractors, trailers and buses. Write for your copy of Catalog KU-201 today.

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9 NEW and 4 REVISED
Aeronautical Standards & Recommended Practices
were issued
July 1, 1955

19 NEW and 24 REVISED
Aeronautical Material Specifications
were issued
August 15, 1955

For further information please write

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29 WEST 39 STREET, NEW YORK 18, N. Y.

"MONOBALL"®
Self-Aligning Bearings

CHARACTERISTICS

ANALYSIS		RECOMMENDED USE
1	Stainless Steel Ball and Race	For types operating under high temperature (800-1200 degrees F.).
2	Chrome Moly Steel Ball and Race	For types operating under high radial ultimate loads (3000-893,000 lbs.).
3	Bronze Race and Chrome Moly Steel Ball	For types operating under normal loads with minimum friction requirements.

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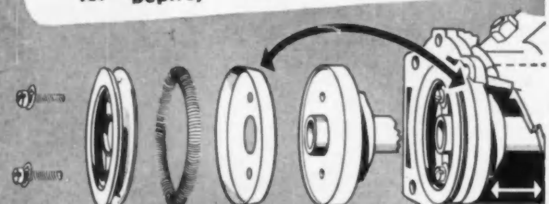

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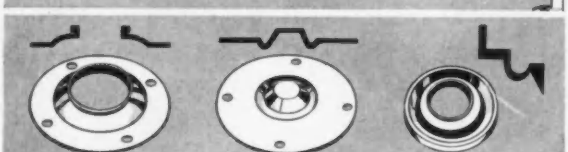

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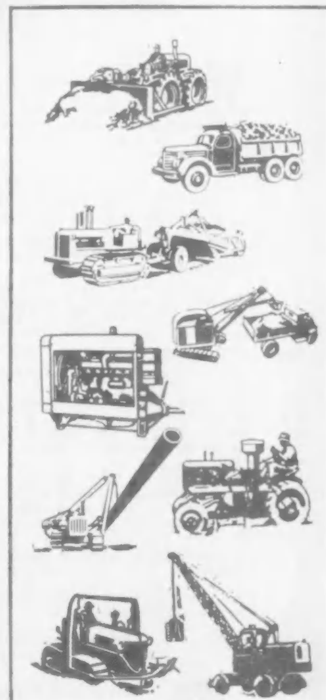

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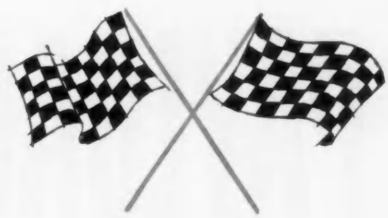

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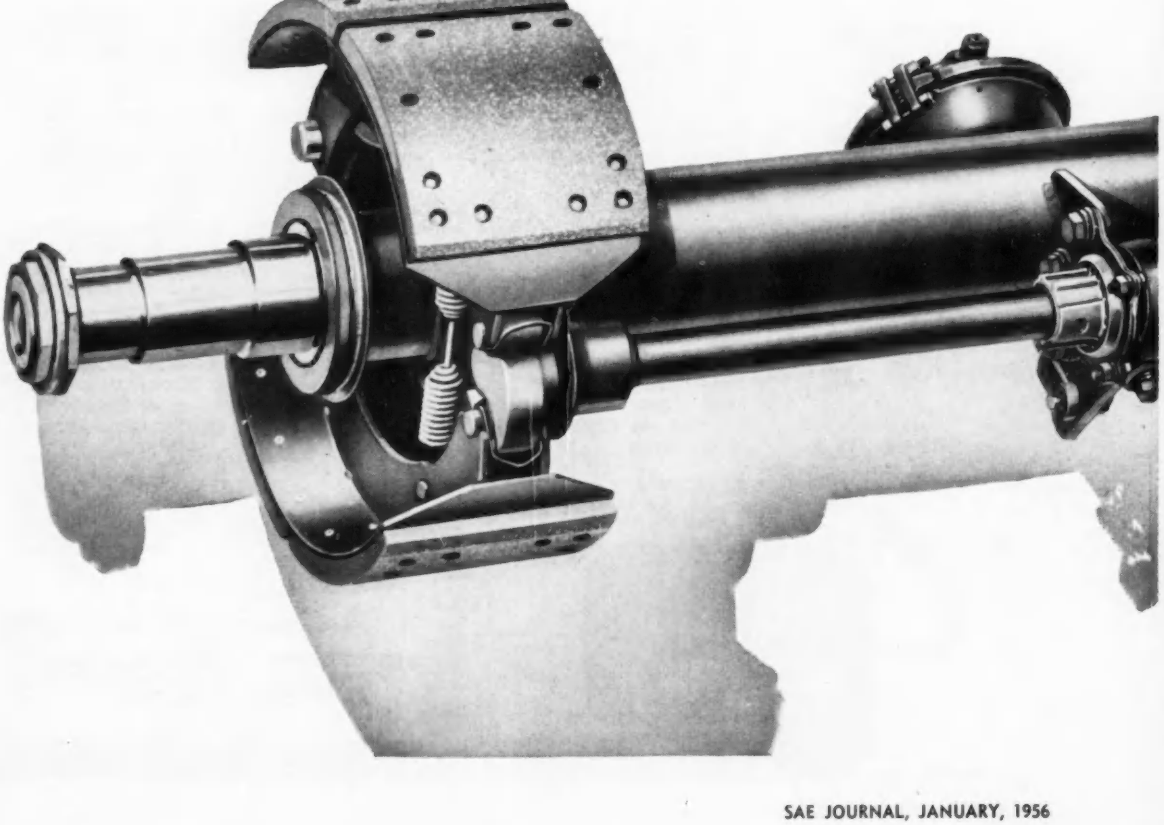

This revolutionary new TK-500 Series Trailer Axle offers far greater weight saving than any other tubular trailer axle on the market. Up to 128 pounds of *extra* payload on single axle trailers and up to 256 more pounds on tandem axle trailers.

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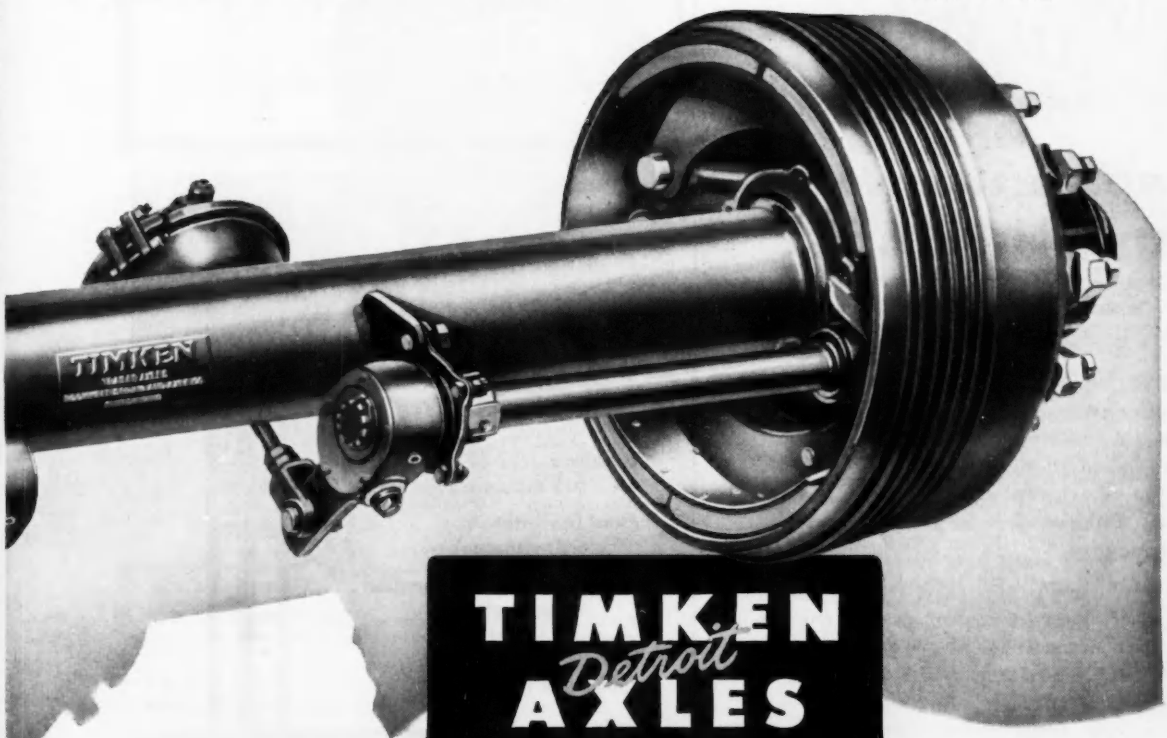

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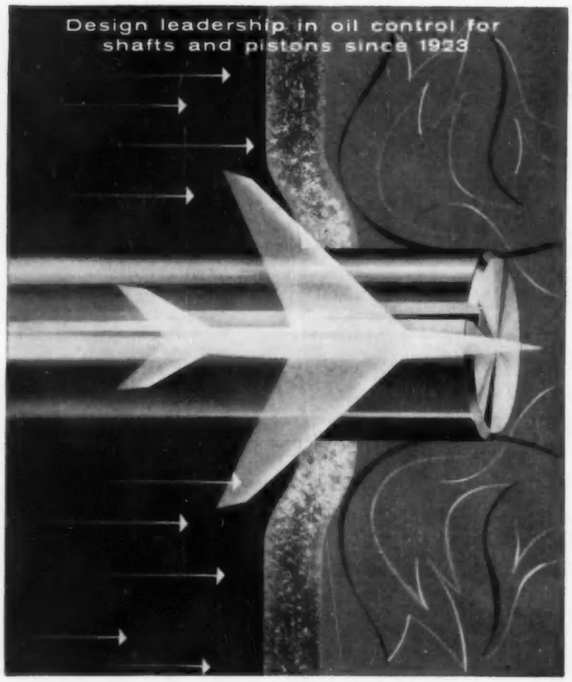

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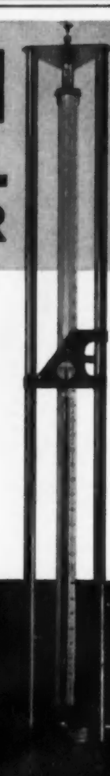

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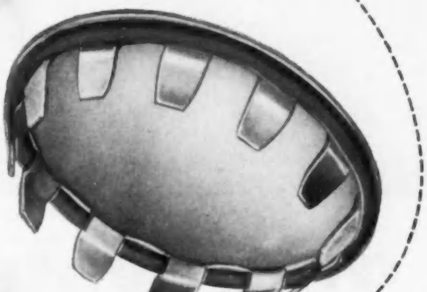

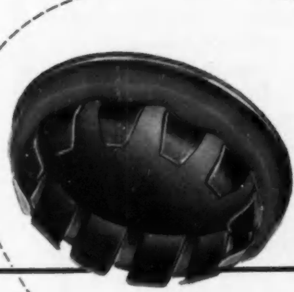

When "snap-in" parts are pre-gasketed by the DAREX "Flowed-in" Gasket Process:

- You *get* a tight seal that prevents vibration, seals out water, dust, dirt and fumes
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The DAREX "Flowed-in" Process is ingeniously simple. A DAREX gasketing compound is *machined-flowed* directly onto the part. This "flowed-in" compound is then cured to form a solid, rubbery gasket which becomes *integral* with the part. Since part and gasket are joined as one unit, your assembly line installation is speeded up. And you get a *positive* seal at lower cost than ever before.

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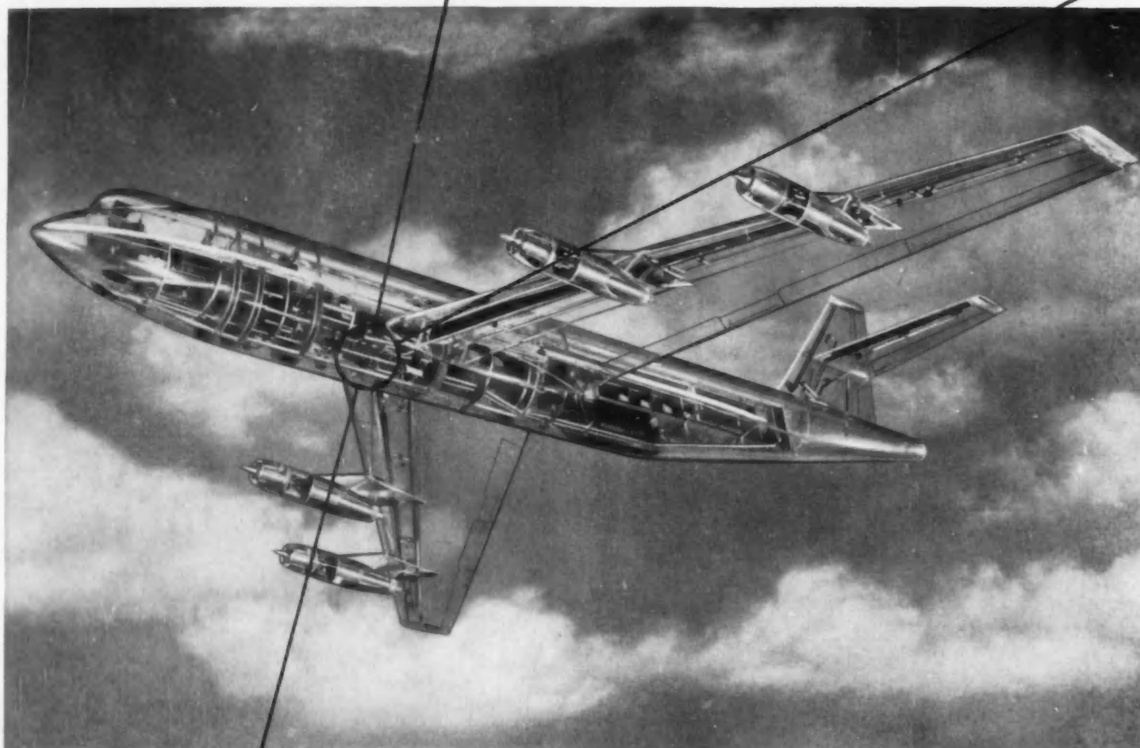
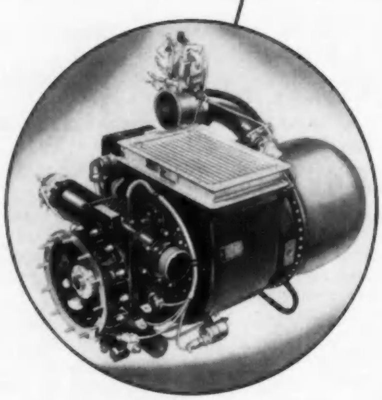


in one system



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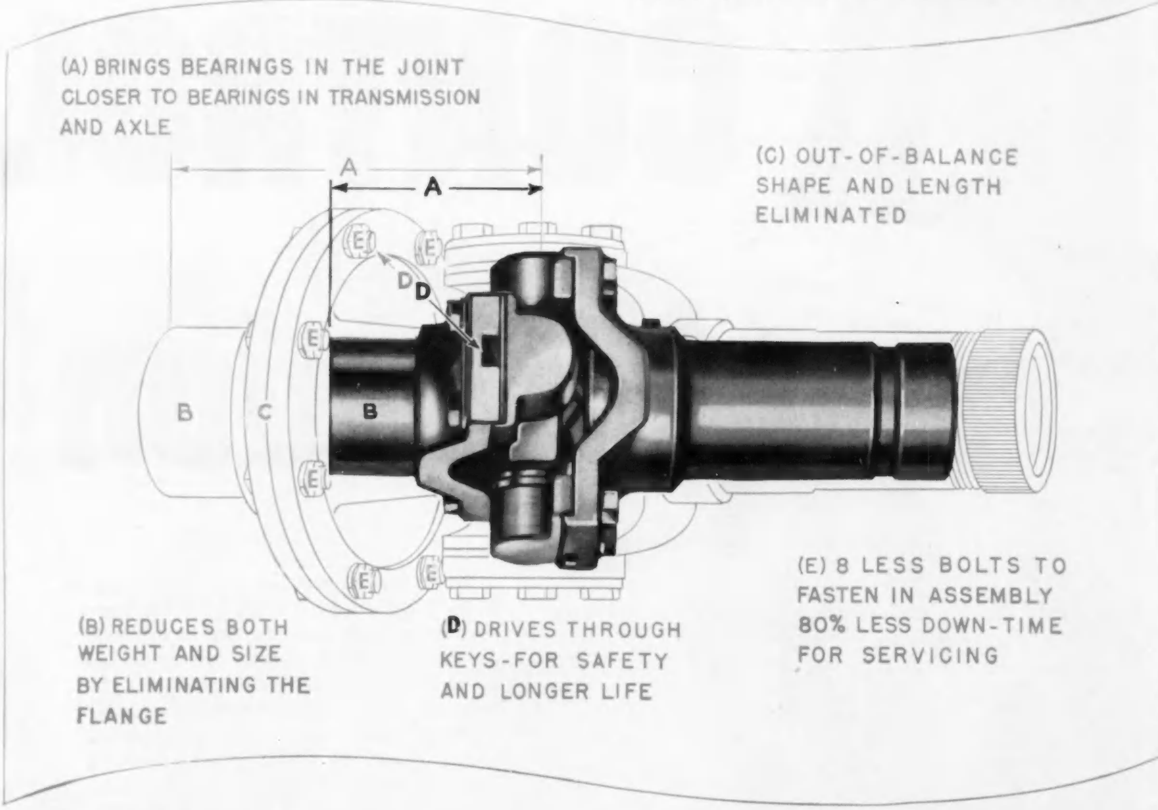

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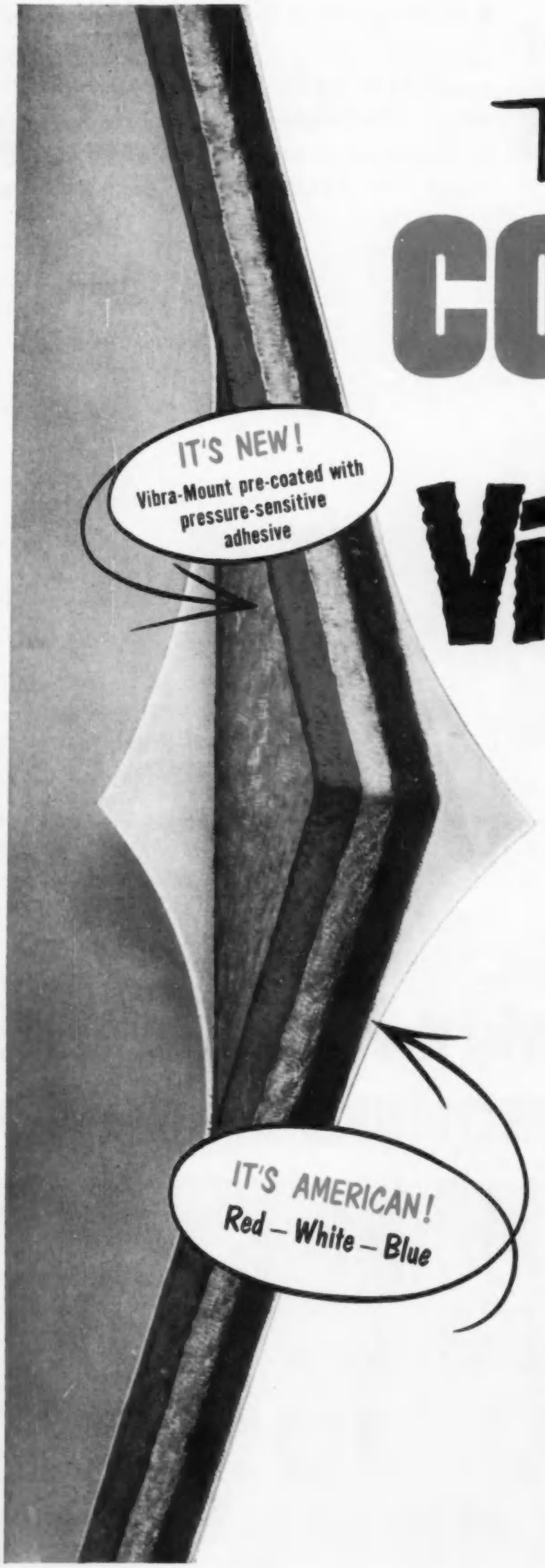

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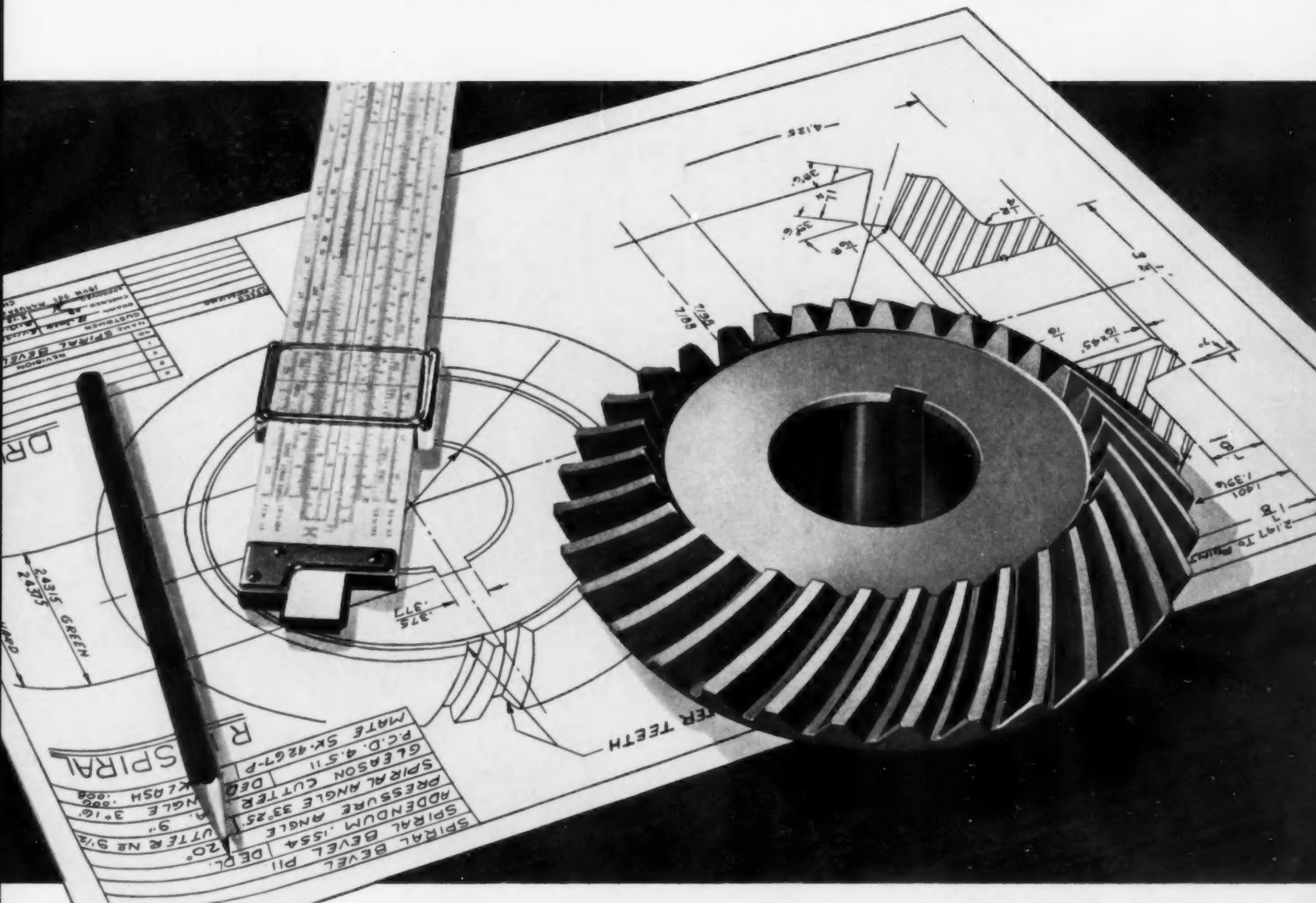

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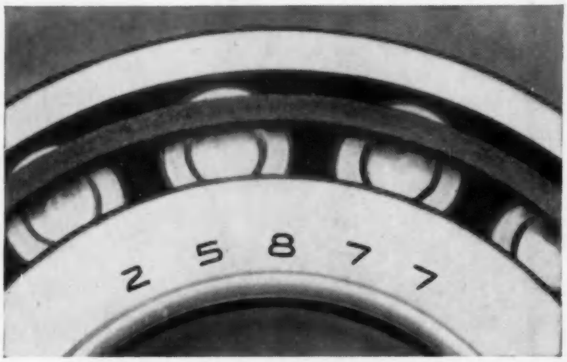

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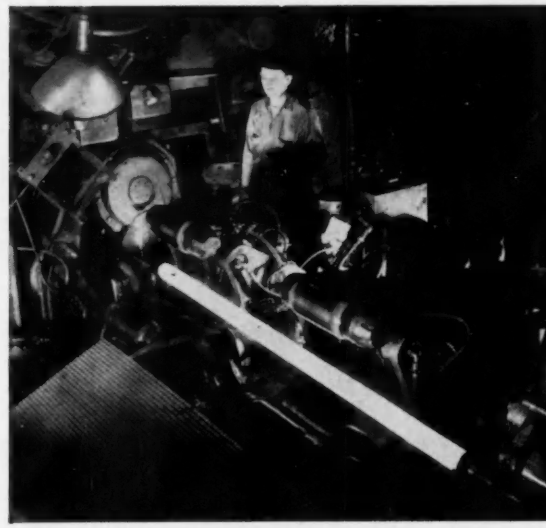

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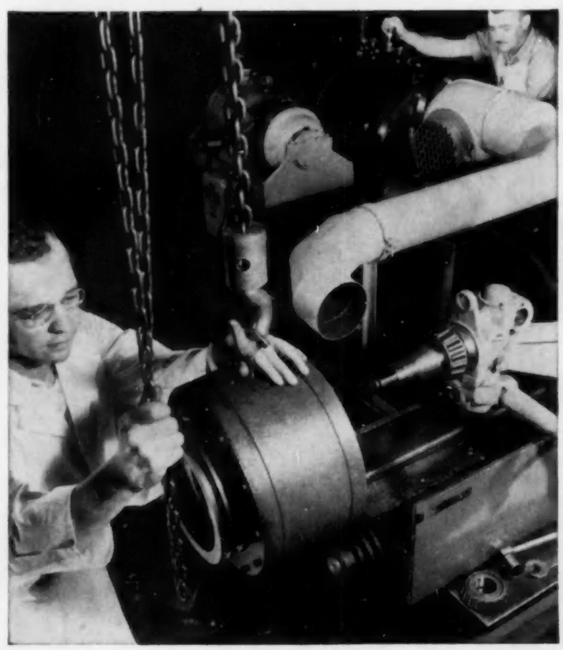

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